NATURE

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Vol. 147 SATURDAY, APRIL 19, 1941 No. 3729

GEOLOGY AND THE COMMUNITY

A GENERATION ago geology was among the sciences which attracted a wide public interest; at the present time not only has public interest greatly declined, but also there are many workers in other sciences who are almost completely unaware of the content of geology. Yet at no time in the past century have geologists been engaged in pressing forward research in so wide a variety of subjects or engaged in so many investigations of fundamental economic importance. Nevertheless, the nature of their work is but vaguely understood by the general public, and they are not always consulted on problems in which they could give useful assistance, because those concerned are unaware that such matters fall within the competence of geologists.

This decline of interest in geology was used by Prof. P. G. H. Boswell to justify his departure from the traditional practice in presidential addresses to the Geological Society of London, of confining the address to a review of the progress of knowledge in a particular branch of geology; in the first part of his address, delivered on March 12, which he entitled "The Status of Geology", he reviewed the present conditions and suggested ways in which interest in geology may be revived.

Until a quarter of a century ago, the Science and Art Department of the Board of Education encouraged the formation of classes in a large number of sciences, and such subjects as geology, astronomy and physiology were then highly popular. While the work was elementary and the courses were open to criticism from several points of view, it must be admitted that they introduced a large number of citizens to the marvels and potentialities of science, and gave them a proper perspective of the history and activities of man. These courses exerted a cultural influence which was very widespread, and teachers whose outlook had been enlarged in such classes further assisted in the spreading of scientific knowledge. At least, the general public became aware of the existence of some of these sciences.

It is, of course, true that science teaching in schools has made much progress since those days, but to a great extent school science has come to mean physics and chemistry, with biology sometimes added; geology has only rarely been included. With the growth of specialist teaching in these sciences, honours graduates in physics and chemistry were in great demand: such graduates had rarely included geology in their curriculum, and thus were generally unable to continue the tradition of informal teaching which had previously served to keep alive an interest in geology. Therefore, in their impressionable years, while many pupils were left in ignorance of the elements of biology, nearly all were unaware of the very existence of geology. Consequently it is not a matter for surprise that the public should now be indifferent to geology.

The seriousness of this position has been recognized by geologists for some time, and efforts have been made to direct the attention of educationists to the problem. The dearth of geology graduates and the difficulty lately experienced in filling posts (especially in the petroleum industry) laid further emphasis on the need for action, particularly in relation to Empire needs, at a time when in the U.S.S.R., Germany and the United States large numbers of geologists were being trained. In 1935 the position

was so grave that Section C (Geology) of the British Association pressed for the appointment of a committee to consider and report on questions affecting the teaching of geology in schools. Reports were published in 1936 and again in 1937 : they directed attention to the claims of geology as a school subject, to its cultural value, to the advantage of its outdoor work, and to the demand for trained geologists, while they also made constructive proposals for the inclusion of geology in the School Certificate examinations, both as a separate subject and as a part of a general elementary science course.

It is as yet too early to estimate the prospects of a revival of interest in the subject through school activities. The Science Masters' Association, though composed mainly of teachers without special knowledge of or interest in geology, has readily recognized the importance of the subject by including it in its revised suggestions for a general science course ("The Teaching of General Science, Part II. Science Masters' Association, 1938). Since the War began, the evacuation of city schools to buildings with inadequate laboratory facilities, in rural areas which are often ideal for field work, has done something to stimulate an interest in the subject. But any further progress must depend on the supply of trained teachers, and here the position of the universities is involved.

The number of university students taking advanced courses in geology (apart from those designed for engineering and mining students) has diminished greatly in recent years. While there are several reasons for this decline, there is no doubt that it is due mainly to the growth of the Higher School Certificate examination in England and Wales, and to the granting of exemption from the first year of study in many universities to the holders of such certificates. Although this scheme may have worked well in the training of specialists in chemistry and physics, in existing conditions it has worked towards the elimination of those subjects which are not taught in schools. The choice of a student's university course was frequently made on the basis of the 'Higher' subjects taught in his school : he was 'no good at science' if he had not marked aptitude at physics and chemistry. Possibly this state of affairs would be changed if students were normally required to take a wider range of subjects at the university and to include at least one science which they had not previously taken at school ; it is significant that in some Scottish universities, where an honours student in one science may be required to take courses in three or four other subjects, the numbers of geology students are still considerable.

For the more satisfactory teaching of general science in schools, it is clear that graduates having some acquaintance with four or more sciences (and a somewhat more special knowledge of one or two) are likely to be most successful. The growth in awareness of geology, if many students of other sciences learn something of its scope and methods, will be of great value both in education and in applied science.

It is probably owing to the lack of public awareness of geology that so few geologists have been given opportunities to assist in the war effort. Yet, Prof. Boswell emphasized, we hear of deplorable wastage of money and labour (and therefore of all-important time) which geological knowledge would have prevented if it had been applied ; he thought that on every Divisional Intelligence Staff in the Army there should be at least one officer in whose training geology had found a place. When the organization of regional commissioners was set up, a geologist was attached as adviser to each commissioner, but apart from occasional inquiries little regular use has been made of geological knowledge. Yet during this time there has been great activity in establishing camps, works, shelters, etc. ; the work would have been sufficient to occupy the relatively small numbers of geologists available, but for the most part they have remained unused, having to be content with the knowledge that their qualifications were set out on the Central Register ; many have undertaken other service in which their special abilities are lost to the country. Meanwhile, it was noted, there are reports of "operations in which geologists have been given no opportunity to be effective—of works placed in unsuitable locations, camps and reception areas where water is inadequate and drainage unsatisfactory, water-logged trenches and air-raid shelters, and (as though rising in a crescendo of incompetence) the case of an ill-chosen aerodrome site".

The members of the Geological Survey have, of course, been active in a variety of ways, and have done admirable work on many problems which, unfortunately, owing to the exigencies of war-time publication, is not so widely known as it should be. They have been concerned with the investigation of mineral resources (particularly of supplies to replace those normally imported), of water supplies, drainage and other problems. But Prof. Boswell contended that the staff of fifty geologists,

even with occasional collaboration of other geologists, is too small to cope with all the difficulties created by war-time activities. Further, he is of opinion that the total number of geologists (including suitably qualified amateurs) available in Great Britain is scarcely sufficient to deal effectively with the numerous problems and the large area to be surveyed.

Even at this stage in the War, there is no reason why it should not be more widely known that geological assistance is available: what is particularly desirable at the present time is that consideration be given to the widespread ignorance regarding the scope and content of geology, so that the available information will be utilized freely when plans for post-war reconstruction are being discussed. This can best be assured if geology regains its position in the educational schemes of Great Britain, so that an acquaintance with its achievements and methods is gained by a larger number of educated people, including those who will be engaged in administration as well as those who will themselves work in, or utilize, the materials of the earth's crust.

FEDERATION AND ITS IMPLICATIONS

Federal Tracts

No. 1: Peace by Federation? By Sir William Beveridge. Pp. 34. No. 2: Economic Aspects of Federation. By Prof. Lionel Robbins. Pp. 32. No. 3: The Colonial Problem and the Federal Solution. By Norman Bentwich. Pp. 32. No. 4: What Federal Government Is. By K. C. Wheare. Pp. 24. No. 5: The Philosophy of Federal Union. By C. E. M. Joad. Pp. 40. No. 6: Socialism and Federation. By Barbara Wootton. Pp. 32. No. 7: Federal Union and the Colonies. By Lord Lugard. Pp. 32. (London: Macmillan and Co., Ltd., 1941.) 6*d*. net. each.

THE wide measure of public attention which the idea of federalism has come to command since the outbreak of the War is already attested by a considerable volume of literature. Several alternatives to the plan proposed in Mr. Clarence Streit's "Union Now" have been closely discussed, and a good deal of attention devoted to problems and difficulties over which Mr. Streit appeared to pass too lightly. If, however, the precise form in which the idea was advocated by Mr. Streit is unlikely to find wide acceptance, the whole trend of events has given fresh urgency and importance to the concept of a union of States.

This urgency derives from two main sources. In the first place, it is realized that if we are to utilize the opportunity which the loosening effect of the War upon our corporate institutions gives us, the mental preparation which must form the basis of any sound plan of world order must be done now, even in the stress of war. Only so can we hope to avoid the mistakes which are bound to be made if we defer the problem until hostilities end and a policy and line of action are demanded without delay. In the second place, our exposure of the Nazi New Order of tyranny and slavery for the subject races should not lead us to overlook the extent to which some semblance of order is implied in such a domination. It imposes on us the obligation of offering to the dominated peoples, when released from Nazi tyranny, not the old disorder, but a new order of free peoples.

These reasons alone give pertinence to the discussions on world order and reconstruction which have been proceeding with fresh vigour during the past autumn and winter, and to the educational campaign which has been fostered by the New Commonwealth, Federal Union and other organizations. That educational work is indeed fundamental. If opportunities are to be seized by the statesmen of this and other countries when the time comes, they must be assured of the support of an informed public opinion, clearly understanding what is involved in any sacrifices of national sovereignty that may be required.

For this reason alone the admirable series of pamphlets which Federal Union has arranged to publish under the name of "Federal Tracts", with the view of promoting informed discussion of federation, is to be warmly welcomed. These pamphlets, of which the first seven have now appeared, are written by authorities on their subjects and express the personal opinions of the authors. Federal Union as an organization is not committed to the views expressed in any of the tracts, and the writers themselves, while interested in federal problems, will not necessarily be members of the Union.

The first two of these pamphlets are not new. No. 1, "Peace by Federation?" by Sir William

Beveridge, written in February, 1940, for private circulation, was included in the first series of "World Order Papers," published last autumn by the Royal Institute of International Affairs; Prof. L. Robbins' "Economic Aspects of Federation" was originally contributed to the symposium "Federal Union" edited by Mr. Channing Pearce and published by Messrs. Jonathan Cape last year. These two acute analyses of the possibilities and limits of federalism are now given to a wide public and form a fitting introduction to the series. Together with the fourth pamphlet in the series, "What Federal Government Is," by Mr. K. C. Wheare, they give a fair and concise account of the problems involved in federation as they present themselves to-day.

Sir William Beveridge, after discussing the problems involved in selecting the areas to be included in a federation, and the division of powers, outlines very briefly a federal constitution. Much of the interest of his contribution, however, lies in the line of approach which he suggests and his proposals for the new step and for dealing with the difficulty of Germany. His cautious approach is unlikely to satisfy the more ardent followers of Mr. Streit's school, but his insistence on a gradual approach and the necessity of limiting the area of federation will commend his argument to constructive minds. World federation, he holds, is for the millenium. Sir William is concerned with the next peace treaty and with the establishment of a super-national government adequately empowered to defend its authority and maintain the peace.

Federation will come when communities recognize a common interest, for which it is worth sacrificing something of their freedom. Sir William Beveridge does not indeed postulate that nations are even yet ready for federation. He sees no other proposal as likely to achieve order, and he rests his proposals on facts: the spectacular changes in the scientific and material equipment of mankind, making out of date old tribal groupings and isolations, and particularly the special revolutionary facts of the unification of Germany and of aggressive Communism in Russia. These facts between them have changed the conditions of peace in Europe and the forms of government required there.

This practical moderation is characteristic of the series and adds considerably to their educational value as a stimulus to thought. Mr. Wheare indeed lays much of his stress upon the difficulties of federalism. It has normally been difficult to establish a federal government. Its operation requires great skill and tact. Its success depends upon an enormous patience and capacity for compromise among the statesmen who work it. Swift and decisive government is impossible, and deep and dividing issues must be avoided. Compromise, conservatism and legalism must of necessity be the virtues and vices of successful federal government.

It is wise to recall the limitations and weaknesses of federalism when proposals to establish a new federal government are under consideration. Only by taking careful account of them can we avoid disillusionments or placing upon the federation a strain it is not fit or intended to bear. If federal government is not always appropriate or easy to work, it is at least government and order, and if the division of powers is wisely and carefully made, it should be possible to reap the advantages of federation while retaining the capacity for rapid executive action in the appropriate spheres which may be essential for efficiency. Federalism, after all, is not an end in itself, but a means of providing a system of government where people are prepared to surrender only certain limited powers and wish to retain other limited powers, both sets of powers to be exercised by co-ordinated authorities.

Few federations in fact are completely federal, and there is nothing to prevent the adoption of strict federalism in some matters and only a modified federalism in others. A written constitution is essential, however, for a federal government, and the amending process should be operated unilaterally neither by the federal government nor the State governments—a condition which obviously precludes any consideration of Germany under her present regime entering a federal system. Furthermore, a supreme court which determines the meaning of the constitution in case of dispute, and financial self-sufficiency for each of the co-ordinate authorities, are other essential features of a federal system of government.

Prof. Robbins, and also Mrs. Barbara Wootton in the sixth tract, "Socialism and Federation", cover much the same ground but from different points of view. Prof. Robbins urges the desirability of leaving to the constituent States as much economic freedom as possible and of eliminating the possibility of those conflicts of sectional interest which under independent national sovereignty might be causes of international friction. He urges that what restrictions or regulations are placed on migration and inter-State trade should be imposed by federal, and not State, authority. Similarly, though wide diversity in monetary system and industrial structure might be permissible within the federation, control of money and capital movements within the federation should be essentially a federal function. Again, federal permission or approval should be required for local collectivist experiments which involve restriction or discrimination.

"Socialism and Federation" is a defence of the thesis that socialism and federation are complementary. Social progress is contingent upon international order, and conscious and planned direction of economic life over a wide area is essential, in the opinion of Socialists, to achieve equality and prosperity. A federal constitution which gave concurrent powers to both State and federal governments to legislate on labour matters, providing only that in conflict the latter would prevail, might enable a system of federal minima to be combined with higher standards in the more advanced States while relieving the latter of fear of their low-standard neighbours.

Mrs. Wootton enforces her argument by referring to the decision about European unity which will confront us who reject the Nazi tyranny under which it has been temporarily imposed. Merely to break it is to forget the logic of twentieth century technique and the wider horizons of twentieth century citizenship, and to re-establish only disorder, tariffs, currencies and barriers. To adopt the alternative of transforming the Nazi empire involves a new political framework such as federalism provides.

The fifth pamphlet in the series, by Prof. C. E. M. Joad, "The Philosophy of Federal Union", should appeal to the scientific worker in particular. The philosophy of federal union, Prof. Joad points out, is largely concerned with the question whether the supercession of powers or transfer of functions from national governments to a federal government is possible or desirable, and he proceeds to an examination of the Fascist philosophy of the State, in which he shows that that philosophy is not only unsound and unscientific but also incompatible with federalism. The individual has rights other than those conferred upon him by the State and duties other than those which he owes to the State.

Prof. Joad argues that the State is not a final but a transitional form of human organization, one among many evolved in the course of man's history. Changes in human environment resulting from man's inventiveness have already made it a political anachronism. Man's advances are due to the individual and not to the State, which has hindered, opposed or suppressed rather than promoted creative thought. Indeed the power of the State has become a menace to human happiness as well as to creative thought, and the supercession of the State has become the crying need of our time. The rule of law can only be established if States are deprived of the power to set aside the authority of law as Federal Union proposes.

Prof. Joad, however, goes further. Federal union has a positive philosophy to offer. The outstanding defect of our civilization is the disparity between our powers and our wisdom, our technical knowledge and our virtue, our science and our ethics and politics. Our problem is that of so organizing our lives both as members of communities and as individuals that we may reap the benefit of the new opportunities of living that science has won for us.

Federal union offers its first contribution to the solution of that problem by enlarging the boundaries of the political unit so as to adjust it to the reality of the underlying economic structure. Moreover, in a world where habit has taken the place of principle and State worship has led to ethical anarchy, federal union offers in the brotherhood of man a creed to live for, and in the supercession of the obsolete form of organization which impedes it, a principle to live by. The ethics of federal union prescribe the duty of enlarging the sentiment of patriotism to include within the scope of its concern the members of other States.

Prof. Joad refers finally to the need for strengthening democracy with the conviction that only religion can command, and with the enthusiasm which only religion can generate. It may well be that federal union, he concludes, can only be achieved and the rights of the individual preserved, if the enthusiasm which religious faith can generate can be harnessed in its service. These Federal Tracts are well calculated to inspire that intelligent understanding of the problems involved which forms the basis, not only of an adequate plan and policy, but also of the conviction and enthusiasm required to ensure their execution.

The remaining two of the pamphlets deal with the colonial question. In the first of these, "The Colonial Problem and the Federal Solution," Prof. Norman Bentwich, reviewing the major problems which the colonial territories present, discusses the alternatives possible in a federal system, and emphasizes the impossibility of establishing a peaceful order with an approach to world citizenship, whether by federal union or any other way, unless we are prepared to renounce national advantages and privileges in governing territories inhabited by less developed peoples and to let people in other countries have a part with us. Lord Lugard, writing on "Federal Union and the Colonies", urges that centralized administration is not workable, and advocates supervision of Colonial economic policy by a standing committee of the Federal Council, similar to the Mandates Commission. He stresses the importance of the principle of equal opportunity and the prohibition of racial and religious discrimination, but strongly opposes some federal proposals such as those of Dr. Ivor Jennings.

R. BRIGHTMAN.

LIQUEFACTION OF GASES

The Separation of Gases

By M. Ruhemann. (International Series of Monographs on Physics.) Pp. xiii+284. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 21*s*. net.

IN the preface to this book it is stated that "it is high time that deep refrigeration received adequate attention in this country". Dr. Ruhemann has therefore written a volume to remedy this lack of knowledge on the part of British men of science, in order that the subject may be taught in the universities. Certainly the average text-book of physical chemistry does not deal in much detail with the working of liquid air and similar types of plant. The reason is quite obvious. The principles of the subject were worked out many years ago. They are expounded in all works dealing with the equilibria of vapour-liquid systems. But their application has become a matter of very specialized engineering practice, naturally confined to those concerns whose job it is to build and operate low-temperature refrigerating plants. It is not the function of the average university lecturer in physics or in chemistry to teach engineering practice to his students. The author's crusade for courses on "deep refrigeration" is therefore unlikely to be taken up with any great enthusiasm in Great Britain. None the less, the book provides a great deal of information which has not hitherto been dealt with in any connected manner. In this respect it is welcome to chemists and physicists alike.

The early chapters deal with the principles of the subject, first with the vapour-liquid equilibria of two-component systems, next with systems of three components. Much recent data are presented in convenient graphical form. There is a chapter on the thermodynamics of gas separation, particular attention being paid to the types of diagram most useful for discussing equilibria in this field. As might be expected, there are full descriptions of the various types of liquefiers, with estimates of the efficiencies reckoned in gallons of the desired liquid per kilowatt-hour expended. Unfortunately from a practical point of view, the capital cost and maintenance of the plant are left out of consideration. While the scientific efficiency is of great interest, the over-all cost of running a plant is the determining factor in its adoption in practice.

Several chapters are rightly devoted to the separation of air into oxygen and nitrogen in either liquid or gaseous form. The isolation of the rare gases is described, but as a matter of interest the details of the method of separation and purification would have been welcomed by the average reader, who would like to know just how the pure samples, now available commercially, are prepared. There is here no mention of the use of charcoal in manipulating and purifying rare gases. Such a method is, of course, unlikely to be used on a large scale, but knowledge of this kind is undoubtedly useful to those working with these gases. It must be mentioned that there is a chapter on the separation of helium from natural gases.

The liquefaction of hydrogen and of helium are unfortunately left out of account. Admittedly, only the favoured few now handle these liquids, but the technique developed for their production, manipulation and use is of the utmost interest to anyone likely to read a book on the liquefaction of gases.

The production of hydrogen and even of methane from coke oven gas receives great prominence, and cogent arguments are brought forward to show that hydrogen so produced for use in synthetic ammonia plants is an economic proposition. The plant, however, is so complicated that it seems unlikely that it would compete with alternative methods of making hydrogen–nitrogen mixtures of the required composition and purity. The isolation of the constituents of cracked gases in the petroleum industry is described in the last chapter of the book. This is a subject upon which much work will be done, but the paucity of published results makes it difficult for the author to give more than an outline of what has so far been accomplished.

Much of the more recent data and statements of fact given in the book are derived from Russian sources, although a certain amount is culled from the United States. There is, however, often a lack of references to the source of information. This makes it very difficult to assess the value of such statements. In a scientific book of this character, it is not sufficient to say that in the U.S.S.R. such a plant is working at a certain efficiency, unless the figures are backed by reference to a detailed description of the plant in some journal of repute.

The volume is produced in the customary excellent style of the Clarendon Press.

H. W. MELVILLE.

THE MAN OF SCIENCE AS ARISTOCRAT

By H. G. WELLS

THE other day I listened with great pleasure to Sir Richard Gregory's Aldred Lecture[1], and admired once again his instinct for bringing together into the most fruitful association, facts and consequences lying far apart, and extracting wide suggestions and new problems from the assemblage. But the readers of NATURE do not need to be reminded that Sir Richard was a brilliant editor so that without any sacrifice of its world-wide scientific usefulness he also made this weekly journal a medium of interpretation and understanding between one type of specialist and another and between specialists in general and the man of general intelligence and broad curiosity outside the ranks of the specialist worker. The Royal Society began as an assembly of curious gentlemen, amateurs all, and how else could it have begun ? It could include Pepys, for example, to his great benefit certainly and maybe to its own.

I find that very relevant to Sir Richard's discussion, and Prof. Hill's stimulating address on scientific co-operation[2] comes in at a different angle to the set of problems Sir Richard has set going in our minds. He gave us no solutions, and it may be there is no simple comprehensive final reply to the questions he had started. Is there a real hard-and-fast difference between discovery and invention, between pure and applied science, between philosophy and science, between the professional and the amateur, between gentlemen and players, between the inventor and the patentee ? One can imagine a sort of preposterous Royal Commission sitting to define the boundaries and calling a fantastic crowd of witnesses. The discussion would slop over into the world of artists and writers and of all who deal in thought and knowledge. Is it within the honour and dignity of a writer to write an advertisement ? Or to write a book pandering to popular sentimentalities he despises ?

But if we admit the boundaries are indefinable, it is still arguable that there are centres to this peripheral vagueness. There are types and groups and individuals, almost completely disinterested in their contribution to human achievement, and there are others whose activities are deliberately directed to gainful research. Again we have another group whose end is neither the good, the true or the beautiful, but a definite practical end. Thinkers unduly influenced perhaps by the materialist interpretation of history have it that every step in invention and discovery has been a response to a very present need. Man had long wanted to practice agriculture in a methodical manner, and so he took up astronomy ; he wanted to fix the boundaries of his fields in a wide flat plain and so he stretched out his hand into the unknown, and behold ! geometry was there. He wanted to go places and so he leapt upon the hitherto merely edible horse and supplemented its insufficient sturdiness by breeding and the wheel. I put these things from one angle, but one can quite easily turn the point in the other direction. When man rumbled off in his first chariot, was he looking for something practical he needed urgently, or was he just looking for trouble ? No community would have kept and fed an astronomical and geometrical priesthood unless it had fulfilled a vital practical need. But how far the priest created the need he also satisfied is one of those head-spinning questions best dealt with by a gathering of convivial anthropologists after dinner. For the answer to almost all these conflicting questions seems to be : "Well ; to a certain extent—*yes*."

But to push further into the luminous fog into which Sir Richard and Prof. Hill have lured me, and which I find so stimulating that it has kept me awake at nights, it is, I think, possible to define the practical problem to which their thoughts are directed. It is the protection of progress. They both think that human living should be and can be made more abundant and happier by the progress of discovery and invention, and they are agreed that that progress is only possible in an atmosphere of world-wide free expression, publication and exchanges. Free expression is the breath of human hope.

But neither of them stops at that. Sir Richard in particular upsets a whole beehive of notes of interrogation beyond that primary demand. The driving force responsible for the rapidity of human progress in the past century and a half has been, he evidently thinks, discovery. Exploration, fundamental research, discovery, is the root from which the immense wealth of modern invention springs. Lying abed at nights I have disputed that, but it is true. I thought of the bicycle as an invention that owed nothing to discovery, that might have happened anywhen. The idea of the hobby horse, one might think, is old as the wheel ; a fair road was necessary, but there were good roads in the early empires, and I would not be surprised to find a hobby horse in a Sumerian

burial mound, just as one might find a prehistoric glider in Crete. There would have been nothing fundamental in adding a treadle to the hobby horse. The penny-farthing boneshaker was equally open to man, therefore, except—except that that big wheel was impossible, and it was impossible because of the backwardness of metallurgical practice. The 'safety' was still more impossible because of the lack of skill and material for gearing. The invention of the practicable bicycle, like the glider, has had to wait throughout the ages therefore until the fruits of scores of remote explorations and discoveries had filtered down to practical exploitation. It could not have happened earlier than it did, and only as a consequence of that fundamental work.

So that the preservation, multiplication and cultivation of the 'pure' discoverer is the primary solicitude of all of us progressives, and it becomes an inquiry of primary importance to the liberal thinker to reveal what are the political and social circumstances that will produce this type in maximum abundance and satisfactory activity.

Last winter I flew over most of America. I visited a number of universities and among others the great technological organization at Pasadena. I saw the great lens of the Lick Observatory being rubbed slowly to a perfect curvature, and I brought my knowledge of the chromosomes of the fruit-fly up to date with my old friend Prof. T. H. Morgan. The atmosphere was charged with considerable political excitement because of the presidential election, and I found a very curious divergence of opinion between the elder and the younger men of science. The older men had found their opportunity through the endowments provided by rich men, and they seemed to be unable and unwilling to contemplate any other way of sustaining research. Except in social and economic science, the yoke of the patron had been easy to bear, an almost imperceptible weight. The endowment paid its money for distinguished achievement and the man of science had a free hand, and the more he carried himself as a distinguished mental aristocrat, the more he gave satisfaction. But in our world of rapid revolution the very foundations of this conditional security are threatened, and these elder men of science are, so far as my knowledge goes, politically Tories to a man. They have a real and justifiable fear of the State politician, of journalistic denunciation, of a vast paralysing network of control. They do not want to change the rule of the wealthy patrician for that of the political commissar.

This, however, is not the case with the progressive recalcitrant sciences, and among the younger men of science in all departments I found a lively disposition to get on with a new world and to find in an extension of federal activities in the way of research and educational facilities a substitute for the spontaneous and rather incalculable generosity of the now deflated wealthy. I will not take sides here and now. I report what is happening merely to raise the question of how the scientific worker is to adjust his pride and honour to this new and dangerous change in his sustaining conditions.

He may have to face not simply difficulty and poverty but bitter frustration. To do that he will have to set aside any pseudo-modesty that afflicts him. By resolving to become a primary research worker he decides that he is one of a necessary *élite*, an aristocrat in a democratic world. How can he decide that? If he feels that his research work is better worth while than anything else in the world, then probably it is worth while, and if he does not feel that, he had better turn to something 'with money in it'. He must not wait for a grant or anything, he must go ahead with it, whatever it is. Curie could do that. Think of the poverty of his life throughout, and how he died, and then think of all that the world owes to him. This world to-day is his.

My old friend, York Powell, told me years ago, "Your first duty is to the gift within you. It does not matter whom you offend nor how you sacrifice your popularity. Do the thing that you are impelled to do. Everything else is secondary to that impulsion." What holds good for the writer, holds good for the primary research worker. It is the same problem.

The philosophy for the essential research worker I submit is a stoical aristocracy. I note with interest and a certain cynicism the suggestions of our authors for gratuities and patents. Do any gratuities get to the original discoverers? I doubt it. Years ago I took up the idea of Diplock's pedrail and applied it to the problem of trench warfare. Diplock was the originating inventor. I described a tank and how it could be used to break an entrenched deadlock, in 1903, in a story called "The Land Ironclads". Years afterwards I discovered that some enterprising gentleman had secured a considerable gratuity as the "inventor" of the tank. His imagination stopped short just where my story stopped short. He had no idea of how to use the tank, and the British Higher Command made an utter mess of the job. It might have decided the war in 1916. I was kept in the dark as to what was going on or possibly I might have broken out with some saving suggestions. Later on, de Gaulle was quite unable to teach the elderly French generals the principles of mechanized warfare, and the Germans last year were the first people to make an intelligent use of the tanks. But anyhow my gratuity (or Diplock's) was

intercepted. That is likely to happen constantly. Interception will become an art if gratuities multiply, and I do not see how one can circumvent the 'Smart Alecs' without a tedious amount of litigation and worry that would distract one from one's proper work.

Much the same thing applies to patent rights. I doubt if many patents give any protection to original inventors. There also I have had some slight but edifying experience. I wrote a book about a "time traveller", and about that time the new "instantaneous" photography appeared. Mr. Paul came along to me and we took out a provisional patent that would have made us practically the ground landlords of the entire film industry. We nearly patented films! We did not go on with the patent. Happily. Otherwise we should have found ourselves corruptingly rich, and a heavy incubus on the development of the cinema. It would have been a mere fluke, a lucky anticipation of unsuspected possibilities, a hold-up.

I can't answer for Mr. Paul, but I have no doubt that all that ill-gotten gain would have demoralized and wasted me completely. My egotism would have been inflated. It would have snatched me from honest work and brought out the latent arrogance and detestableness in my nature. I might have become a Press peer. I might have endowed and dominated futile *ad hoc* research. I might have joined the privileged class which can treat men of science and civil servants and the like as though they are Greek slaves. Happily, it did not dawn upon us until too late what a vast commercial opportunity we were missing. Our provisional patent lapsed.

Those particular experiences make me equally sceptical of the effectiveness of the gratuity and the patent. It seems to me that in the end the research worker, the philosopher, the author or the artist must fall back upon his innate conviction of the supreme value of his work. His ultimate resource is pride. With that he must be prepared to sustain himself against adverse conditions. He must do his best always. He must endure the bludgeonings of fate. Those who detect his quality may be able to put laboratories, transport and material at his service, but they must not insult him with offers of prizes and profits and honours, they must fight for that unrestricted freedom of expression without which he is muffled and made ineffective, and the rest lies with him. He has to hold to it and insist that so far as his work goes he is an aristocrat, an angular aristocrat it may be, but the only kind of aristocrat the new world has any use for. It matters very little if he is poor, gauche or shabby. Without any pretence of false modesty he has to bear himself as an aristocrat not only within himself but among his peers, whether they like it or not. He is the key man of the New World.

[1] The Royal Society of Arts Aldred Lecture, 1941: "Discovery and Invention", by Sir Richard Gregory, Bt., F.R.S.

[2] Address by Prof. A. V. Hill, "Science, National and International, and the Basis of Co-operation", NATURE, 147, 250 (March 1, 1941).

DIFFUSE REFLEXION OF X-RAYS

By G. D. PRESTON,

NATIONAL PHYSICAL LABORATORY

THE diffuse reflexion of X-rays by crystals was the subject of a discussion held by the Royal Society on February 6, when the theoretical and experimental evidence was reviewed by a number of speakers. By way of introduction to the views put forward concerning the origin of diffuse reflexions, a short historical summary of the subject will not be out of place.

The presence of stray reflexions, spots or streaks, is familiar to anyone with experience of taking Laue photographs. In many cases they are due to crystal imperfections, strains, etc., caused in the process of mounting the crystal or in cleaving it to a convenient size for examination. But even after care has been taken to eliminate all such causes, there still remain reflexions the presence of which is not explicable by the usual theory of crystalline diffraction. Such reflexions were first recorded by Friedrich[1] in a Laue photograph of sylvine in which short, faint streaks appeared running radially through the most intense Laue spots; he did not, however, offer any explanation of their presence. Ten years after Friedrich's photograph was published, Faxén[2], as a result of a theoretical investigation, suggested that these streaks were due to the disturbance of the regular geometrical atomic pattern by thermal agitation of the atoms. His work and that of Waller[3] was so complicated that the implications of the theory have lain concealed for some fifteen years beneath a mass of mathematical symbols.

In the interval the attention of experimenters has been focused on the verification of the simpler theories of Darwin[4] and Debye[5], in which the effect of temperature in diminishing the intensity of the normal reflexions was investigated. This

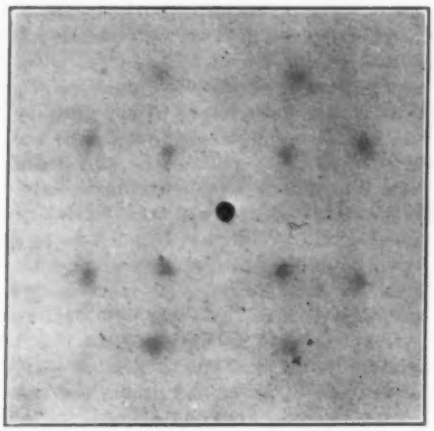


Fig. 1.

ALUMINIUM AT 500° C. MONOCHROMATIC SILVER *Kα* RADIATION PARALLEL TO A CUBE EDGE.

concentration on the X-ray reflexions associated with integral indexes (*hkl*) was natural at a time when the application of the new method to the study of crystal structure opened up such a wide field for research. The very weak background reflexions were rightly regarded as of secondary importance.

Within the last five years, interest in these faint reflexions has been aroused and they have been studied simultaneously in several laboratories. Some of the anomalous reflexions are due to crystal imperfections caused during growth or to the occurrence of a chemical reaction in the solid state. Examples of these two phenomena are to be found in minerals[6] and in metals[7]; in both cases the background reflexions are to be ascribed to minute imperfections in the crystal.

There are, however, background reflexions which are associated with the thermal vibrations of the atoms in the crystal. These are of fundamental importance because they form an integral part of the spectrum of the crystal and cannot be separated from the normal reflexions. It was shown by Preston[8] in 1939 that Laue photographs of aluminium, sodium chloride, magnesium oxide, zinc and diamond had background reflexions which became more intense as the temperature of the crystal was raised. One of these photographs is reproduced in Fig. 1; it was obtained by means of a monochromatic beam of silver *Kα* radiation falling on a single crystal of aluminium at 500° C. perpendicular to a cube face. There ought to be no spots on this photograph because the Bragg condition is not satisfied for any crystal plane; the faint pattern of spots with fourfold symmetry is due to the thermal waves in the crystal. Preston suggested that the pattern was due to the presence in the crystal of small groups, consisting of an atom and its neighbours, which diffracted X-rays more or less independently.

Slightly in advance of Preston's investigation, Laval[9], using the ionization spectrometer and monochromatized copper and molybdenum radiations, carried out an investigation of the background intensity and its variation with temperature, using six different crystalline substances. Unfortunately, the full account of his work was published in a journal not very readily accessible to physicists and has for that reason been overlooked. If we represent the normal spectra of a crystal by the points of which the co-ordinates are integers (*hkl*) in reciprocal space, then we can describe an important part of Laval's work as a study of the distribution of intensity near these points and the determination of surfaces of constant intensity surrounding them.

In the United States, recent interest in background reflexions seems to have originated in the publication of a Laue photograph of rock salt by Wadlund[10]. This picture showed a remarkable system of streaks similar to, but very much more intense than, those recorded by Friedrich in the photograph of sylvine already referred to, but almost certainly arising from the same cause. The matter was taken up from the theoretical side by Zachariasen[11], and the effect is ascribed to the thermal vibrations of the lattice, the formal explanation following the lines of the Faxén-Waller theory.

Sir C. V. Raman[12] and a number of collaborators have described their observations of anomalous reflexions from diamond and other crystals. The new spots are referred to by these authors as 'modified' reflexions, their presence being ascribed to an effect analogous to the Raman effect in the

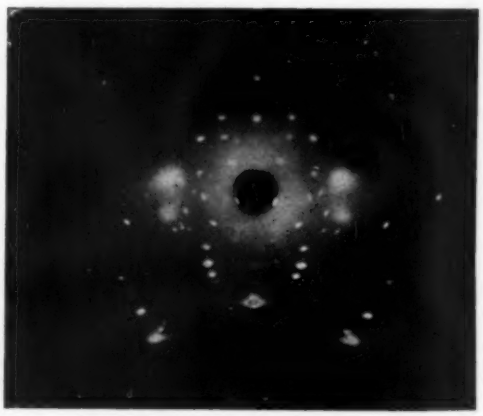
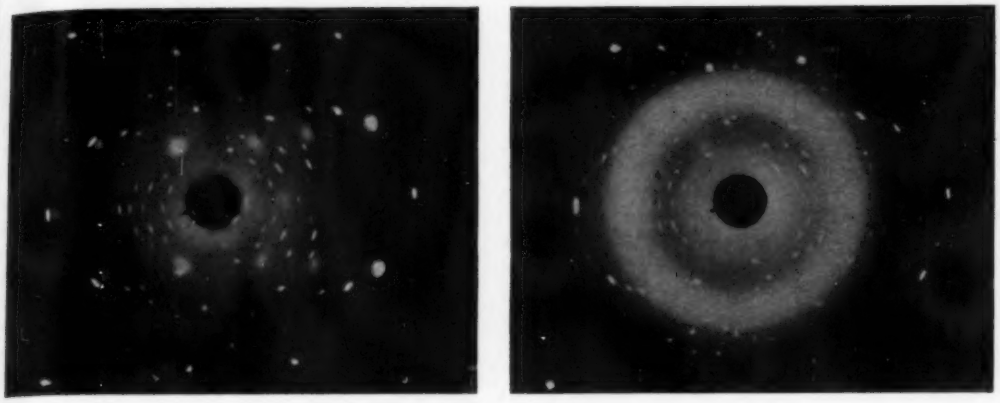


Fig. 2.

LAUE PHOTOGRAPH OF SORBIC ACID.

Note diffuse spots of different shapes, due to 'layer'- and 'chain'-type planes.



a *b*

Fig. 3.

LAUE PHOTOGRAPH OF α-RESORCINOL.

(*a*) Showing arrangement of diffuse spots in layer-lines. Crystal enclosed in fine 'Cellophane' tube, at room temperatures. Photographs before and after liquid air experiment are identical.

(*b*) Same orientation and exposure, at liquid air temperatures. Intense diffuse ring due to liquid air stream. Note almost complete disappearance of diffuse spots and improvement of Laue picture.

optical region of the spectrum. The 'modification' implies a change of frequency accompanying diffraction, the change being too small to measure. In essence, Raman's interpretation agrees with that of other workers in ascribing the anomalous spots to the presence of elastic waves in the crystal. It is not at the moment clear whether Raman considers the waves to be due partly to temperature vibrations or solely to excitation by the passage of the X-ray beam through the crystal. The dependence of the intensity of the spots on temperature was, however, demonstrated for sodium nitrate.

The most recent, and much the most comprehensive, study of temperature spots comes from Dr. K. Lonsdale[13], a full account of whose work will appear in the *Proceedings of the Royal Society*. She has obtained a large number of photographic records of the diffuse spot effect, some of which have recently been exhibited at the Royal Institution. Her main conclusions may be briefly summarized as follows :—

(1) The diffuse spots may be seen on X-ray crystal photographs of every kind and measured on the ionization spectrometer. A much longer exposure is generally required than in the case of a Laue photograph. She found it convenient to use the 5-kw. tube of the Davy Faraday Laboratory and sometimes the 50-kw. tube to record the spots.

(2) The diffuse spots are due to the diffraction of the characteristic X-rays, as others have found.

(3) Each diffuse spot lies close to, or in the same position as, the Bragg reflexion from some crystal plane, the indexes of which can be found by a slight rotation of the crystal ; and the spots are found only under conditions in which the corresponding Bragg reflexion can be found by such a rotation. This means that the pattern of diffuse spots corresponds very nearly with the pattern of Bragg spots formed when the crystal is oscillated through a small angle on either side of the position in which the diffuse spots were recorded.

(4) The intensity of a diffuse spot is related to the intensity of the corresponding Bragg reflexion and to its separation from it.

(5) Radial streaks on Laue photographs are generally due to diffuse reflexion of white radiation.

(6) Monochromatic radiation sometimes produces non-radial streaks, notably in the case of benzil. Sometimes patches of diffuse scattering appear and other anomalies not yet explained. 'Layer' and 'chain' structures give diffuse spots differing markedly in shape and in other respects ; the study of these diffuse spot patterns may provide valuable assistance in structure determination (Fig. 2).

(7) The intensity and extent of the diffuse spots are strongly affected by temperature, as Preston and others have shown. They disappear at the temperature of liquid air. As the diffuse spots strengthen, the Laue spots weaken, and vice versa, all the effects being reversible (Fig. 3, *a* and *b*).

(8) Considering the effect in terms of reciprocal space, the diffusely reflecting regions surrounding each reciprocal lattice point are not, in general, spherical, but are extended along certain planes and axes. This is proved by the existence of non-radial streaks and accounts for the small movement of the streaks and diffuse spots when the crystal orientation changes. The configuration of diffuse spots observed in diamond and sylvine demonstrates this and shows that the plane of

diffuse scattering is not always coincident with the plane of incidence.

Besides arriving at these general conclusions, Mrs. Lonsdale has considered, in the paper referred to, the relations of the intensity, shape, size, position and persistence of the spots to the nature, structure, perfection, orientation and temperature of the crystal, to the radiation used and to the conditions of photography.

Sir William Bragg[14] has analysed the pattern of diffuse spots produced by sylvine and has found that they correspond to the diffraction effects to be expected from a simple cube of eight atoms. He points out that in all cases hitherto examined the diffuse spot pattern agrees closely with the true diffraction pattern of the crystal under monochromatic radiation, as given by the formula for intensity :—

$$I = (\Sigma m_1 m_2 \cos {}_1\varphi_2) \frac{\sin^2 p\varphi_a/2}{\sin^2 \varphi_a/2} \cdot \frac{\sin^2 q\varphi_b/2}{\sin^2 \varphi_b/2} \cdot \frac{\sin^2 r\varphi_c/2}{\sin^2 \varphi_c/2}$$

In this formula m_1 and m_2 represent the scattering powers of any two centres in the unit cell, and ${}_1\varphi_2$ represents the difference in phase of the waves which they scatter, each centre to be reckoned in conjunction with itself as well as with all the others. The quantities φ_a, φ_b, φ_c, are the differences in phase associated with the three principal translations of the cell, and p, q, r, the number of times that the respective translations are repeated.

If p, q, r, are large numbers, the intensity will be relatively extremely small unless the three denominators are simultaneously very close to zero. This complete coincidence requires the special disposition of the crystal with respect to the incident ray which is prescribed by Bragg's law. But if p, q, r, are small, as in the case of the small groups suggested by Preston, there will be a regular pattern which might be visible if there were enough groups, and would possess, in the main at least, all the properties so far found to be possessed by the diffuse spot pattern, for example, the connexion with the oscillation photograph. The effect of temperature might be due to a change in the number of small groups, as Preston has suggested. The principal translations can be deduced from the pattern as Sir William Bragg has shown for potassium and sodium chlorides, calcite and benzil.

Sir Lawrence Bragg considers Preston's idea of diffraction by small groups of atoms does not fully account for the phenomena observed, and that this is so because it leaves out of account the fact that the groups form part of an extended crystal structure and so cannot be regarded as scattering independently. The observed positions of the diffuse spots obtained with monochromatic light may be explained by saying that diffraction takes place when the phase of reflexion passes *near* a point of the reciprocal lattice, and is not restricted to the special condition of passing exactly through it. This is merely an alternative way of expressing Preston's condition in reciprocal notation. Now, if a crystal is broken up into a number of small independent units, roughly parallel, the points of the reciprocal lattice are smeared out, and the intersection of this by the sphere of reflexion gives diffuse spots ; hence the success of the 'group' idea in accounting for Preston's original photographs and the much more complex ones obtained by Mrs. Lonsdale and analysed by Sir William Bragg. This cannot be the complete explanation, however, because along with the diffuse Preston spots one obtained *sharp* Laue spots and *sharp* spots in a rotation photograph. The whole phenomenon must be described by saying that at each point of the reciprocal lattice there is a sharp central spot surrounded by a diffuse cloud ; both spot and cloud must be ascribed to the same crystal, and both must be explained simultaneously.

The distortion of an extended lattice by heat-waves provides the explanation. The superposition of a periodic heat-wave of wave number n upon a lattice of wave number N produces periodic components in the crystal structure of wave numbers $N \pm n$, $2N \pm n$, $3N \pm n$, etc. Corresponding X-ray reflexions can thus be obtained, and appear as a pair of 'ghosts' on either side of the main reflexion. The whole complex of heat vibrations exactly fills the reciprocal lattice space with these ghosts, and it can be shown that the ghosts nearest to the reciprocal lattice points are the strongest, because the longest heat-waves displace the atom to the greatest extent. Hence the reciprocal lattice at low temperatures is a series of discrete points, whereas at high temperatures a cloud of ghosts fills all the space and is strongest near the points of the lattice, which latter diminish in strength but remain sharp. This is precisely what is observed. If the crystal effectively broke up into groups of atoms, sharp Laue or rotation spots would no longer exist ; their persistence at high temperatures shows that we must take the phase relationship right through the crystal into account.

That the small groups which apparently render a simple and accurate account of the observed spots do not appear explicitly in the formal theory does, at first sight, throw very serious doubt on their existence. Darwin, however, suggests that the fact of their absence from the analysis is not in itself sufficient ground for dismissing the idea as false. To illustrate this point, he draws an analogy with the analysis of the rise and fall of the tide in an estuary. Owing to local conditions there might,

for example, be a long period at low water when the level did not change appreciably. The Fourier analysis would predict this feature of the tidal change quite accurately, but would not indicate the precise physical cause (the draining of a large expanse of sandy foreshore) which produces the effect. In the same way the Fourier analysis of the thermal disturbance of the crystal would predict the intensity of X-ray reflexion correctly, but, as information concerning the phases is lacking, the presence of groups could not be predicted.

In discussing the theoretical problem offered by the experiments on background reflexions on Laue photographs, Prof. Max Born inquired whether the phenomena can be explained by the well-established theory of scattering or whether new assumptions are necessary. He observed that the fact that Sir William Bragg's formula represents the position of the spots so well, suggests that it should appear as a result of a theory more satisfactory formally, than the assumed presence of small groups of atoms. It seems that an improved theory of the effect of thermal vibrations should provide an adequate explanation of the observations. The important fact emerges that just as the Laue spots, or Bragg reflexions, determine the geometry of the lattice, so the background pattern is a complete image of the main features of the dynamics of the lattice.

The observation of effects similar to those discussed above has been recorded by Charlesby, Finch and Wilman[15] using the method of electron diffraction. Their experiments show that for molecular crystals, such as anthracene, the thermal vibrations of the lattice produce a background pattern. The effect is somewhat similar to that of a vapour in which all the molecules are oriented and produce a pattern which should reflect the symmetry of the molecule. It appears that the X-ray effect is not identical with that observed with electrons, for some of Mrs. Lonsdale's photographs of benzil do not produce a pattern characteristic of the benzene ring when the crystal is examined in a suitable orientation.

The whole subject of background reflexions is evidently one of very considerable interest and no little complexity; further investigation, both theoretical and experimental, should provide information regarding the structural imperfection of crystals, whether of thermal or other origin.

In preparing this article I have been greatly helped by Sir William Bragg, Mrs. Lonsdale and Sir Lawrence Bragg. It is with pleasure that I acknowledge my debt to them.

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CENTENARY OF THE PHARMACEUTICAL SOCIETY

THE centenary of the foundation of the Pharmaceutical Society of Great Britain occurred on April 15, 1941. Thirty years ago, congratulating the Society on its seventieth anniversary, NATURE observed that it was "an event of considerable interest, which is not wholly confined to those who practise the art of pharmacy". The same may be said, with emphasis, on the occasion of the centenary. It is no small thing even for an institution to survive ten decades. The mere fact is proof of its stamina and its usefulness; a hundred years on and how many fall by the way. The Pharmaceutical Society has gone from strength to strength, and it may be said to-day that its place among the nation's useful foundations was never more secure and its service to the State never more highly esteemed or more needed.

Just as among individuals, a man often owes his virility and his good purpose in life to his parents, so does the Pharmaceutical Society owe much to the scholarly Quaker, William Allen, F.R.S., who has been justly called its father, and was its first president. He was the owner of a chemist's shop in Plough Court, Lombard Street, London, and it seems strange that in the days when the practice of pharmacy was in the hands of a heterogeneous mass of tradespeople, most of whom were without scientific knowledge and but poorly equipped with the materials of their business, there should be

found among them a man of high scientific attainments, a fellow of the Royal Society, one of the founders of the Askesian Society for practical research, who had lectured at the Royal Institution and at Guy's Hospital. Besides all these things, William Allen was confidential adviser to Edward, Duke of Kent, the father of Queen Victoria; it was on the advice of this City druggist that the Duke consented to place his property in the hands of trustees, the consent being given on condition that William Allen was one of them.

There is little wonder, then, that those members of the craft of pharmacy who were sufficiently enlightened to see the need of organization chose this outstanding personality as their leader; and the Society having been established by a resolution passed at a meeting held at a Strand tavern on April 15, 1841, it is not surprising that with such a man at its head the infant body put down education as the first item on its programme. Before the end of the first year a course of lectures had begun at 17 Bloomsbury Square, which was then, as it is now, the Society's headquarters. The policy was initiated of securing as lecturers men of high standing in their particular branches of science, a policy which has been maintained ever since. A year later, the School of Pharmacy—now recognized as a school of the University of London—was established, and soon a chemical laboratory, the first of its kind in Great Britain and the equal of those existing at that time in Germany and France, was set up. A system of examination was instituted, and in due course there was available to physicians the services of a new class of craftsmen well equipped by training and education for the purpose of their calling.

It was not until the Pharmacy Act, 1852, was passed that statutory recognition was given to those who passed the examinations, and not until 1868 that the Society succeeded in impressing upon Parliament that the best way of protecting the public from the dangers inherent in the mishandling of poisons was to reserve the retail sale of these substances to trained vendors. Even to this day, the practice of pharmacy has never been restricted by legislation, but fortunately the law now furnishes means by which the public can distinguish a pharmacy which is under the management of a qualified person from a shop which is not so managed.

Space does not permit extended references to the valuable work done by the Society in connexion with the production of the "British Pharmacopœia", or to many of its other activities, notably its scientific meetings, directed to the spreading of knowledge among its members. The quality and advanced nature of the research work now undertaken in the College of Pharmacy is seen in recent reports from its several departments. Thus in the pharmaceutical chemistry laboratories investigations have been made with the view of bringing recent developments in our knowledge of carbohydrates into the domain of medical substances by work on specific sugars in immunological work, and promising work has been done in connexion with œstrogens. Investigations made in the Department of Nutrition have shown that the pigeon test still appears to be the least accurate of the biological methods for the determination of the vitamins. In the Department of Pharmaceutics, research work has been directed to the investigation of pharmaceutical apparatus with a view to improvement in design, particularly in respect of small-scale types. In the Department of Pharmacognosy detailed studies have been made of the flowers of the belladonna plant, and examinations have been made of Jamaican and Surinam quassia. Work done in the Department of Pharmacology comes under such headings as the assay of cortical hormone, the pharmacologically active substances liberated by adreginic nerves, the pharmacology of antipyretics of the aromatic amine series, the mechanism of porphyrin excretion, the toxicity of certain bactericides, the pharmacology of eucalyptus oil and the chemical assay of powdered ergot.

The above is but a small selection of the subjects which have occupied the attention of research workers of the Pharmaceutical Society, but it serves to show how truly it has endeavoured to fulfil the obligations placed upon it by the Royal Charter of incorporation to advance the knowledge upon which the art of pharmacy is based. It is a far cry from 1841 to 1941, when one reflects upon the state of pharmacy as it was when the Society was founded and as it is to-day. There has been, of course, a slowing down of research activities since the outbreak of war, mainly because of the reduction in staff. Prof. J. H. Gaddum, director of the Pharmacological Laboratories, undertook an appointment under the Government for the duration of the War, and other members of the Society's staff have also been called to different duties. Nevertheless, useful research work continues to be done in the several departments.

Sufficient has been said to show that the Pharmaceutical Society of Great Britain well merits the congratulations it has received not only from kindred institutions in other countries, but especially from the bodies representative of the medical profession, which recognizes that the debt it owes to pharmacy is a debt owed to the Society.

OBITUARIES

Dr. Eugene Dubois

DR. EUGENE DUBOIS who, exactly half a century ago, discovered in Java the fossil remains of that strange being which he regarded as transitional between ape to man and to which he gave the name *Pithecanthropus erectus*, died at his home in Haarlem, Holland, on December 16, 1940. The discovery of the most famous of missing links was announced to the world by a monograph published in Batavia in 1894 and entitled "Pithecanthropus erectus, eine Übergangsform". No single discovery in the realm of dead things has given rise to such a voluminous literature, to so many animated discussions or to so many divergent opinions. There are not so many alive now who remember the arrival of Dubois in England in the autumn of 1895, and saw with their own eyes the material evidence of man's evolutionary past which he had just brought back from Java, and took part in the debates which the discovery aroused. Right to the end of his life Dubois maintained that the being he had unearthed was neither man nor ape, but represented a stage which marks the transition from ape to man. Some of his Continental critics regarded Pithecanthropus as a gigantic gibbon; others gave the thigh bone to an extinct form of man and the skull cap to an extinct form of ape. British anatomists, on the other hand, took the view that Pithecanthropus was a hominid—an early form of man.

In 1898 Dubois again came to Great Britain, to attend the Fourth International Zoological Congress, held in Cambridge. He, the late Sir Grafton Elliot Smith and I were guests of Dr. W. L. H. Duckworth at Jesus College. By this time Dr. Dubois had succeeded in extracting from the skull cap the stony matrix which had filled it and had taken from its interior a cast reflecting the features of the Pithecanthropoid brain. A glimpse by the expert eye of Elliot Smith revealed to him features in the brain which were altogether human; it was a very early human stage which had been discovered. This verdict was confirmed by the Pithecanthropoid family unearthed in the Trinil formations of Java by Dr. Koenigswald during 1936–39[1]. There was much doubt, too, as regards the geological horizon to which Pithecanthropus should be assigned. Dubois favoured a late Pliocene date; the consensus of opinion now is that the date is early Pleistocene, which makes Pithecanthropus a contemporary of Peking man in China and of Piltdown man in England.

In 1925 I gave the following account of Dr. Dubois[2]: "If Dr. Eugene Dubois had been born in the 16th century his spirit of adventure would have found its outlet on the Spanish Main, but being added to the population of Holland in the latter half of the 19th century, when Darwinian ideas were spreading across Europe, he went in search of the 'missing link'. Having finished a training in science and in medicine at the University of Amsterdam in 1888, he became a military surgeon, choosing Java for his service. Before setting out for that island, he promised his fellow students, in all seriousness, to bring home the missing link".

This statement brought me a long letter from Dr. Dubois giving several important and desirable details relating to earlier years of his career, details which will become of increasing interest as years go by. The greater part of this letter is reproduced here in his own English:

Haarlem,
2nd April, 1925.

"Let me express my gratitude for the personal kind note on the discover of the Wadjak Man and Pithecanthropus. At the same time I beg leave to correct some personal statements.

"It was not a spirit of adventure but of scientific reasoning (see a paper in the 'Natuurkundig Tijdschrift voor Nederlandsch-Inde" of April 1888) that pithecoid human forms should be expected in pleistocene or pliocene deposits of the Malayan Archipelago, that induced me to undertake palæontological researches in that archipelago. Before I went to Sumatra (where I expected to make excavations in the many caves of the Padang high lands) in 1887, I had been, during seven years[3], Max Fürbringer's assistant and pro-sector, finally lecturer on Anatomy at the University of Amsterdam. . . . My purely scientific work had been chiefly of comparative anatomy, expecially on the larynx. . . .

"I did not promise my fellow students, in all seriousness, to bring home the 'missing link', but I did tell Prof. Max Fürbringer and Max Weber, my motives why I preferred to give up a certain and beautiful anatomical career for an uncertain one as a field paleontologist, the only way giving access to the latter being that of engaging as a military surgeon in the Neth.-Indian army.

"The paper in the 'Natuurk. Tijdschr.' and some paleontological results of excavations of caves in Sumatra, then induced the Ned.-Ind. Government to charge me officially with *paleontological researches in the pleistocene and pliocene deposits of Sumatra and Java*. From these I brought home a collection at least five times as large as that of the Selenka expedition (1906). I collected also in the Siwalik Hills.

"Pithecanthropus was not found in the 'Hell' of Java, but near that 'Hell', this being the garrison town of Ngaur, in the neighbourhood of Trinil, owing its name of 'Hell' to the circumstance that it was in former times a military convict settlement. . . . In 1898 I was appointed as professor of Geology and Paleontology at the University of Amsterdam."[4]

On returning to Europe in 1895 Dr. Dubois placed only a little of his goods in his 'shop-window'; right on to the end of his life he fetched surprise packets from his back-shop. In 1920 he produced the Wadjak fossil skulls, although he had found them before Pithecanthropus came to light. It was the publication of a description of a fossil skull

found in Australia that made him release the Wadjak specimens—which also had Australoid characters. In 1924 he at last published excellent illustrations of the brain cast of Pithecanthropus and also produced a piece of a fossil mandible which he had found in 1890 and now attributed to Pithecanthropus. In 1932 he produced fragments of three more thigh bones of Pithecanthropus.

The cemetery of fossil man which was discovered and exploited by Dr. Dubois in Java has proved to be rich beyond any other in every respect—rich in actual numbers and in types which preserve details of the sequence of humanity that has flitted across the time stage of Java these million of years past. The series begins as ape-men and ends in the aboriginal type of modern Australia. Only in this Australo-Malayan part of the world is the evolutionary history of man known with any degree of fullness[5], and for this we are chiefly indebted to Dr. Eugene Dubois.

A. KEITH.

[1] See NATURE, 144, 926 (1939).
[2] "Antiquity of Man", Second Edition, p. 438.
[3] Dr. Dubois was above medium stature, and although full-bodied, carried himself rather rigidly erect. When in England in 1895 he seemed to be under thirty years of age; from the above statement one infers he must have been born about 1858.
[4] This letter, although it contains further interesting details, is too long to give in full; the original is to be added to the library of the Royal College of Surgeons, (London, W.C.2).
[5] See Keith, NATURE, 138, 277 (1936).

Sir Hugh Murray, C.I.E., C.B.E.

SIR HUGH MURRAY died at Nunton Cottage, Bodenham, Salisbury, on February 9. For more than fifty years Hugh Murray was connected with and played an active part in the development of forestry and forestry administration in India and Great Britain; both Bombay and England will long remember him and his delightful personality. Murray was born on April 27, 1861. He was educated at Trent College and took his forestry training on the Continent. He joined the Indian Forest Service in 1882, being appointed to the Bombay Presidency.

As a district forest officer, Murray acquired the reputation of being a hard-working and tactful officer, and this recognition was fully maintained when he reached administrative rank in the Presidency. During the twenty-nine years of his service there were some very difficult forestry problems bearing upon the habits and customs of the agricultural population in Bombay which came up for, if not solution, at any rate settlement for the time being. As he rose in seniority Murray was able to give valuable advice in this direction; especially when he occupied the position of Senior Conservator in the Presidency and Additional Member of the Provincial Legislature. He retired from the Indian Service in 1911.

Soon after the outbreak of the War of 1914–1918, Murray was called into the War Office to advise on the then urgent and totally new question of obtaining timber supplies under war conditions. For three years he was thus occupied, becoming deputy controller of timber supplies in 1917.

The Forestry Commission was inaugurated in 1920 as a result of the Parliamentary Bill of 1919. A number of commissioners were appointed, and a technical assistant commissioner for England and Wales and a second for Scotland. Murray was appointed to the English post, and a better choice at that time could probably not have been made, for senior trained foresters with ripe administrative experience were few in number. His chief work was connected with the acquisition of land for the new State forests, and in this he displayed great ability. He was equally interested in the planting work then being started on a large scale and in the research inaugurated at this period. After four years Murray was appointed a forestry commissioner, thereby strengthening the technical position of the Commission. He remained a commissioner until 1934, when he finally retired.

He married, first, Gwendoline Mabel Langridge and had a son; and secondly, Dorothy Christine, daughter of the Right Hon. Sir William Mather, and had a son and daughter.

E. P. STEBBING.

Mr. J. Picken

MR. JAMES PICKEN, one of the alkali inspectors in the service of the Ministry of Health, died suddenly on February 17, aged forty-six. After a period of service with the Royal Garrison Artillery in France, Mr. Picken took his degree at the University of Glasgow, and was afterwards for some years in charge of the Glasgow Corporation's chemical works at Dawsholme and Provan. He received his appointment as one of H.M. inspectors of alkali works in 1924, and from that time had been in charge of the Sheffield district, where his unfailing tact and courtesy, together with the efficient but sympathetic manner in which he carried out his duties, had earned him the respect and affection of all with whom he came into contact.

WE regret to announce the following deaths:

Dr. Annie J. Cannon, assistant in the Harvard College Observatory during 1897–1911, and curator of astronomical photographs since 1911, aged seventy-seven.

Dr. David Forsyth, an authority on the diseases of children, on April 10, aged sixty-three.

Sir Nigel Gresley, chief mechanical engineer of the London and North-Eastern Railway, on April 5, aged seventy-six.

Prof. K. N. Konstantinovich, director of the Moscow Institute of Experimental Biology and formerly director of the Central Station of Genetics, aged sixty-nine.

Mr. J. C-S. McDouall, O.B.E., formerly director of Medical Sanitary Services, Sierra Leone, on March 25.

Prof. Carlos G. Malbran, professor of bacteriology in the University of Buenos Aires.

Sir Albert Seward, F.R.S., professor of botany in the University of Cambridge during 1906–36, on April 11, aged seventy-seven.

Prof. Roy B. Smith, emeritus professor of chemistry in Colgate University, aged sixty-five.

NEWS AND VIEWS

Prof. Frank Schlesinger

PROF. FRANK SCHLESINGER, who is shortly retiring from the directorship of the Yale University Observatory, is the doyen of American astronomers. His work has been concerned mainly with astrometry, and has been characterized by originality, economy of effort and high precision. As director of the Allegheny Observatory, he used the 30-inch Thaw refractor for the determination of stellar parallaxes. From a masterly discussion of the observations and of the various sources of error, he laid down the methods to be followed to ensure the greatest attainable accuracy. These methods have been adopted at other observatories and have led during the past quarter of a century to a great development in the knowledge of stellar distances. After Schlesinger's appointment as director of the Yale University Observatory, he decided to erect a 26-inch refractor in South Africa to determine the distances of southern stars. This telescope was erected in the grounds of the University of the Witwatersrand, Johannesburg, for this specific programme; and for economy in cost, it is mounted in a meridian building, which restricts its movement to a few degrees on either side of the meridian. Intensive observations with this telescope, in conjunction with those at the Cape Observatory, have made the knowledge of the distances of southern stars almost as complete as for northern stars.

Schlesinger has also been the pioneer in the determination of stellar positions with wide-angle lenses, covering fields up to 100 square degrees, in contrast to the 4 square degrees of the Carte-du-Ciel plates. This has enabled visual observations with meridian instruments to be restricted to the brighter stars and effects a great economy in time in photography at the telescope. Methods of measurement and reduction have been carefully planned to secure the greatest economy of effort. Photographs taken with a camera attached to the telescope at Johannesburg have been measured and reduced in New Haven and, with only a small staff, star catalogues have been produced at a surprising rate. Two compilations, the "Catalogue of Stellar Parallaxes", in which all determinations have been combined with appropriate weights and their systematic errors investigated, and the "Bright Star Catalogue", have proved invaluable for reference purposes. Prof. Schlesinger's sound judgment, sane outlook and wise counsel have given him an outstanding position not only among American men of science but also in international astronomy, and were fittingly recognized by his election as president for 1934–35 of the International Astronomical Union.

Honorary Degrees at Bristol

IN his capacity of Chancellor of the University of Bristol, Mr. Winston Churchill attended a Congregation on April 12 for the conferment of the honorary degree of Doctor of Laws on Mr. John G. Winant, the American Ambassador, Mr. Menzies, Prime Minister of Australia, and (in absence) on Dr. J. B. Conant, president of Harvard University. Referring to the honorary graduates, Mr. Churchill said: "Through him [Mr. Winant] and other distinguished representatives who are with us to-day . . . we make another tie with the illustrious President of the United States, and with the representatives of that vast community at a time when great matters of consequence to all the world are being resolved. . . . In Dr. Conant we have a figure, widely and deeply respected throughout the United States, and particularly among the youth who attend Harvard University, holding up a clear beacon light for young men of honour and courage." Mr. Menzies, he said, has brought with him the strong assurance of the democracy of the Commonwealth that they with us will go through this long, fierce, dire struggle to the bitter end.

Speaking of the occasion as one of rare and exceptional character because the visitors to whom they were showing honours and courtesies are playing an important part in the universal drama which is unfolding, Mr. Churchill said, "Here we gather in academic robes and go through ceremonials and repeat formulas—here in battered Bristol, with the scars of new attacks upon it. Many of those here to-day have been all night at their posts and all have been under the fire of the enemy, under heavy and protracted bombardment. That you should gather in this way is a mark of fortitude and phlegm, of a courage and detachment from material affairs worthy of all that we have learned to believe of ancient Rome or of modern Greece."

Yugoslav Fauna and Flora

THE extension of war into Yugoslav territory takes it into an area of the south-eastern Europe fauna and flora which had only begun to be properly explored by biologists within modern times. The British Museum expedition of 1937 collected four species of Clitellus (susliks or gophers) in Yugoslavia (*Annals and Mag. of Nat. Hist.*, May 1940), two of which were new to science, *Clitellus c. karamani* (named in honour of Dr. Stanka Karaman, explorer of Macedonian fauna), from Karadjica Mountains, Macedonia, and *Clitellus c. laskeri* (named after Prof. V. Laskarer, of the University of Belgrade). Slovenia contains abundant chamois, red and roe deer, bear, wild boar and even lynx, while its avi-fauna includes capercaillie and stone partridge, mostly protected by the 1931 game laws. Spoonbills nest abundantly on the Obekska Bara bird reservation near Belgrade. In the Knez Mihaileva region buzzards and eagles are still well established, while magpies and jays from the Belgrade suburbs have frequently been observed passing over the city.

Flights of wild geese and wild duck, the former coming from the great Hungarian marshes, are frequent sights at the time of hunter's moon. Insect life includes a wealth of butterflies and the curious Yugoslav tiger moth, *Cymbaciophora pudica*, which produces a loud squeaking or clattering noise by its wings in flight. The caves of Dalmatia and Carinthia have long interested naturalists for their blind olm or cave newt, *Proteus anguineus*. The flora is rich in alpine flowers of great beauty. Pančic wrote a useful "Flora of Serbia", and recently Hayek compiled a new Balkan flora. It is an irony that one of its most recent students was Dr. Giuseppi, the Italian botanist and member of the Alpine Club. On his 1930 visit he found *Geranium subcaulescens* on Mount Koprevnia and *Saxifraga montegrina*, receiving the award of merit of the Royal Horticultural Society when introducing the former to British gardens. On Mount Cristen he found *Ranunculus creatus*, and in 1931 on Kerast he found *R. Wettsteisii* and *Ardrosance Hedreantha*, on Ljuetia, *Viola Grisebachiana*. W. B. Turrill, of Kew, also studied the Balkan flora during the War of 1914–18 and three times since. Good herbaria existed at Belgrade, Sofia and Trieste. Tournefort, Sibthorp, Clark, D'Urville and Grisebach collected in the area, which has a flora of some 6,500 species.

International Relations and Federalism

THE February 1941 issue of *Union*, the monthly forum of the New Commonwealth Society, includes a number of articles on post-war reconstruction and the development of international relations. Mr. Duncan Hall, in an address on "What are the hopes of Lasting Peace?" asserts that only by a scientific understanding of the dynamic forces of human nature and human society, by a realistic education and a wise leadership, can we hope to speed up man's progress towards a lasting peace, based on the supremacy of reason and conscience. The problem is far more than one of finding the right institutions and making economic adjustments. It is essentially a problem of how to control the human forces, how to prevent uneven domestication, how to safeguard against mob situations that break down the conscience and reason of the individual and let loose his instinctive forces. Writing on "The Outline of a Long-Term Economic Plan", Mr. W. L. Fairweather urges that the task ahead of us is to raise the level of consumption all over the world, and that many of the controls necessary in war will be extended and developed and remain as a permanent feature of the economic system. Mr. Channing-Pearce's address to the Oxford Branch of Federal Union on January 4 on "The Federal Faith" is included, with its conception of federation as concerned not only with politics but also with sociology and economics.

The Wilkes Centenary

THE centenary of the Wilkes Exploring Expedition of the United States Navy, 1838–1842, was marked by a symposium on American polar exploration organized by the American Philosophical Society in February of last year. The papers read on that occasion are now published (*Proc. American Phil. Soc.*, **82**, No. 5) and include some valuable contributions to polar geography. The expedition is best remembered for its antarctic landfalls, which have since been the subject of much controversy but mainly have been confirmed. The expedition had, however, a practical bias, actuated by the considerable American whaling industry in the Pacific at that time, and the scientific side was not too strong though valuable results were obtained not only in the antarctic but also in many surveys in Pacific islands and numerous biological collections. The greater part of the results were published by the authority of Congress, but the edition was small and many of the volumes are rare. In the present publication the history of the expedition and the story of the struggle to get the reports published are fully traced and there are valuable bibliographical records.

A most useful paper deals fully with the fishes collected by the expedition, a report which has not previously appeared. This is by Mr. H. W. Fowler. Another paper, by Commander F. W. Reichelder, discusses the contributions of the expedition to magnetism, gravity and meteorology. Prof. W. M. Hobbs treats of the geographical discoveries. Another series of papers deals with other aspects of American polar work. Of these may be noted one by Mr. W. E. Ekblaw on the arctic discoveries of De Haven, Kane and Hall and another by Mr. H. J. Lee on Peary's journeys in North Greenland. Two valuable and original papers are those by Prof. L. M. Could on the glaciers of Antarctica, which surveys all the glaciological problems, and one by Mr. V. Stefansson in which, with his customary bold conception, he advocates a ten-year programme of arctic studies to be centred in a number of stations, most of them on the pack-ice, to be established and maintained by air.

Early Man in Virginia

FOR some little time evidence has been accumulating which points to Bedford County, in south-western Virginia, as a place of early settlement of stone-using aboriginal tribes of nomadic hunters. During proto-historic and early historic times, Siouian and Iroquoian tribes appear to have lived within the present bounds of the county; while the Cherokee in the earlier half of the nineteenth century still retained the memory of an old tradition that a Cherokee village once stood near the twin Peaks of Otter in the north-west of the county where it is crossed by the Blue Ridge. These peaks were formerly thought to be possibly among the highest of the northern continent; and it is believed that the region around had been occupied for many centuries by a succession of tribes of different stocks, ever since the time when nomadic bands first entered the wilderness. This belief has now received the support of recent discovery in the form of stone implements of an early type on a site, now known as the Mons site, which was revealed early in 1940 in road-making operations in the vicinity of the Peaks of Otter. In a description of the site and finds by David I.

Bushnell, jun. (*Smithsonian Miscell. Collect.*, **99**, 15; 1940) it is recorded that stone artefacts, fragments of steatite vessels and small bits of earthenware were exposed during removal of the top soil. Although some specimens were obviously older than others, no determination of age was possible in the absence of stratification. Nor was it possible to mark the extent of the settlement; but quantities of flakes of various types and fractured pebbles indicated the existence of a workshop. The types of artefact included flake-knives and scrapers, projectile points, several forms of edged implements, axe-like implements, hammerstones and possibly pestles. Two Folsom points have been found on the site mingled with the other material.

This is the first occasion, so far as is known, on which the Folsom point has been found in the eastern States in association with other material or on a settlement site, though Folsom points of the Eastern type, which is not identical in all details with that of the south-western States, have been found sporadically in Virginia and elsewhere. The specimens from the Mons site may be regarded as clinching the argument for an eastward extension of Folsom man associated with an evolving industry, conditioned at times by the necessary employment of a refractory material. That the nature of the stone and not ignorance of the characteristic technique is responsible for the absence of the groove in the chert points from the Mons site is shown by the occurrence there of flakes of jasper, such as would be produced in the manufacture of a typical point of that material, which has been found no more than two miles away.

Agricultural System of the Argentine

THE Imperial Bureau of Pastures and Forage Crops, Aberystwyth, has recently published a bulletin on "The Grasslands of the Argentine and Patagonia" (*Bull.* 30. 2*s.* 9*d.*). The author, W. Davis, has himself made an extensive tour of South America, and his account contains much of interest to the general reader as well as to the grassland specialist. Patagonia is chiefly a sheep ranching country, carrying a vegetation of open tussock grassland in the south, and shrub steppe in the central and northern regions. In the Argentine proper, cattle are more important than sheep and, compared with Patagonia, farming is much more intensive. As a result, the native flora has been largely replaced by exotic species of both grasses and legumes.

One of the most interesting features of this intensive farming is the practice of fattening cattle on lucerne in the La Plata region. The temporary ley is the basis of this form of husbandry, together with the use of cereal crops for out-of-season grazing. Much of the land is held by companies and by individuals who are fattening cattle on large holdings (*Estancias*), and is worked on a share farming system. The farmer cultivates and crops the land, sharing the crop with the landowner on an agreed basis. After a run of cereal crops, it is a condition that the land must be laid down to lucerne, at which juncture the farmer moves on to another holding, and the owner receives his land back carrying the requisite crop for his cattle. It is suggested that a modification of this system might profitably be used in parts of Great Britain. The bulletin concludes with an interesting account of the *frigorifico* at Buenos Aires, where killing of the cattle and utilization of every part of the carcasses are carried out in a most efficient manner.

The Nigerian Forester

THE idea of issuing a journal in Nigeria or for West Africa generally on the lines of the *Indian Forester* was mooted several years ago. Last year saw a realization when two numbers of the *Nigerian Forester* were published in July and November. The editor appears to be somewhat diffident about the appearance of a new publication in war-time. The paper devoted to its publication, however, is very far from being wasted, for some of the articles appearing in the first number are both timely and of interest. With one exception, where the exotic trees of the Cameroons are dealt with by D. R. Rosevear, the articles in the first number deal with either Northern or Southern Nigeria and present a wide variety of problems. In the second number, in addition to some general articles such as "Termites and Soil Fertility", "Work in the Veterinary Department, Nigeria", and "Some Applications of Grassland Ecology", subjects such as "The Gold Coast Timber Industry" and "First Impressions of Forestry in Sierra Leone" are dealt with.

Perhaps of wider interest, though somewhat sad, is the announcement that the *Nigerian Forester* is to be replaced by another publication on the same lines but with a wider purview, entitled *Farm and Forest*. This publication will be devoted to the discussion of land use problems in West Africa from the point of view not only of the forester but also of agricultural, veterinary and other workers interested in the manifold aspects of rural economy. It will thus have a wider public and should get over the financial difficulty which a specialized journal issued by a small Government Department always has to face.

Underground Gasification of Coal in the U.S.S.R.

THE "Russia Today" Press Service has issued a statement of the progress of work on this problem during the last few years in the U.S.S.R. It is recalled that Mendeléeff envisaged this method of fuel treatment, and about a generation ago Sir William Ramsay suggested the initiation of research thereon in Great Britain. In the U.S.S.R., however, the first practical work was begun in 1933 on the gasification of the coal in the seam. This is reached by two shafts connected by a tunnel cut through the seam itself. The coal is gasified by a blast of air or oxygen and steam blown down one shaft while the hot gas produced is collected from the up-cast shaft. This method necessitates the labour of miners to sink the shafts and to tunnel the seam before gasification can begin. In a new installation in the Donetz coalfield, the seam will be reached by bore holes so that no underground work will be necessary. Last

November a plant, it is said, started operation on an industrial scale in the Moscow coal area to supply gas for chemical manufacture. A new installation in the Donetz coal field is expected to dispense with the services of five hundred miners. Where oxygen is employed to enrich the blast and so produce a gas of higher calorific value and lower nitrogen content, the cost of the separation of oxygen from air largely determines the economics of the process. It is claimed that Prof. P. L. Kapitza has designed a plant for air separation which marks an advance in technical efficiency.

At a time like the present, it is important to picture the possible consequences of these developments. If successful, they would mean the reduction or abolition of one of the most arduous of human efforts, but only if coke could be dispensed with. Coal, once gasified and converted into a mixture of carbon monoxide and hydrogen, becomes not merely a flexible source of heat and power, but also a starting point for the most diverse chemical syntheses. In a highly industrialized country like Great Britain, it would cause the grave problems of unemployment inevitable when remodelling the structure of industry. We need not be unduly timid about this because it will take a long time to surmount the technical and economic obstacles. It does, however, stimulate the spirit of curiosity and the will to look ahead which is often lacking in our old-established industries.

Factory Lighting in Wartime

IN the Engineering Supplement to the *Siemens Magazine* of February 1941, there is an instructive article by Mr. C. J. Misselbrook on "Factory Lighting in War Time". The fifth report of the Departmental Committee on Lighting in Factories issued in June 1940 has given a number of important recommendations on this subject and indicates a minimum standard which, although it would have been regarded a few years ago as unnecessarily lavish, is now in accordance with all good modern lighting practice. The recommendations of the report may be divided into two sections, adequacy and suitability, each of which presents its own problems. War conditions have resulted in the introduction of unskilled or semi-skilled workers into the industrial world and the work of training them is greatly facilitated if they are not expected to strain their eyes on unfamiliar tasks with inefficient lighting. In addition, the calling up of young men and their replacement by older workers increases the need for good lighting, for as a rule the eyes of older people are not so efficient as those of the younger generation, and consequently need more light for the equivalent 'seeing conditions'.

As regards adequacy, the report recommends a minimum illumination of six foot candles without prejudice to any additional illumination required by the nature of the work. This is a large increase on the one foot candle which was considered satisfactory when the last report was published about three years ago, but is easily obtainable with modern high-efficiency light sources. The question of providing illumination raises also the question of the amount of heat produced, which is sometimes excessive and gives rise to uncomfortable working conditions. The lighting specialist can often reduce the amount of heat by using an alternative type of lamp. For example, the 'Sieray' fluorescent tube is a good alternative to the 200-watt gas-filled lamp giving approximately the same amount of light but operating at a much lower temperature. There are many instances where the type and standard of work require a higher intensity of illumination than can normally be provided by general lighting. If this is provided by local lighting, all such points should be fitted with opaque shades, as an imperfectly screened lamp is a very frequent source of glare, leading to eye-strain and sometimes to accidents. With regard to wiring, the question arises when raising the standard of illumination, whether it is more economical to employ electric discharge lamps with their higher initial cost or to rewire the building. Sieray lamps have often proved of great value in such cases, as they can be readily interchanged with tungsten filament lamps with no alteration in the existing wiring.

Royal Geographical Society Awards

THE King has approved the award of the Royal Medals of the Royal Geographical Society as follows: *Founder's Medal:* Captain P. A. Clayton, for his surveys in the Libyan Desert and his application of this experience to desert warfare during recent operations; *Patron's Medal:* Dr. Isaiah Bowman, president of Johns Hopkins University, Baltimore, for his travels in South America and for his great services to the science of geography while director of the American Geographical Society of New York. The Council of the Society has made the following awards: *Murchison Grant:* Mr. C. T. Madigan, for his explorations and research in Central Australia; *Back Grant:* Mr. Alfred Stephenson, for his surveys in south-east Greenland and in Graham Land; *Cuthbert Peek Grant:* Mr. Marcel Aurousseau, for his valuable services as secretary of the Permanent Committee on Geographical Names; *Gill Memorial:* Captain F. Spencer Chapman, for his exploration of high peaks in Sikkim and Tibet.

Announcements

PROF. W. W. C. TOPLEY, F.R.S., professor of bacteriology and immunology in the University of London, has been appointed secretary of the Agricultural Research Council in succession to Sir Edwin Butler, F.R.S., who has retired on account of ill-health.

ON April 8 an earthquake shock was felt in western Japan. Surface faulting took place, which damaged a railway track, causing goods trains to be derailed. No casualties have been reported. On April 9 a strong earthquake was felt at Terni in central Italy. This was followed by a strong aftershock. Neither shock caused damage.

LETTERS TO THE EDITORS

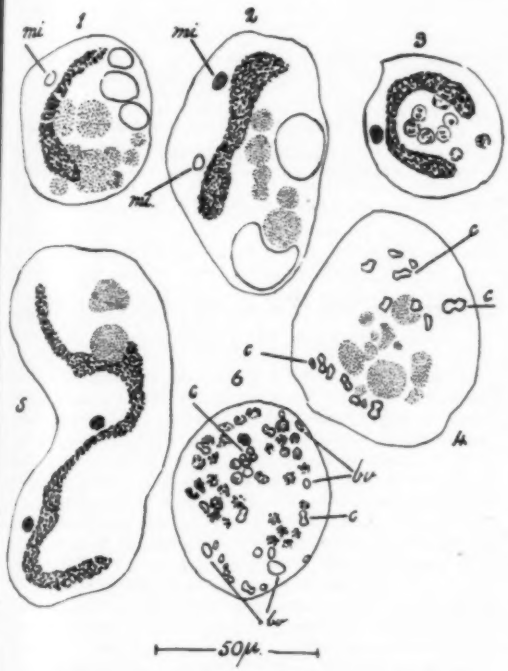
The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Virus Inclusions, Blastogenic Agents and Ciliates

THERE was reported in these columns[1] the production of abnormal Paramecia by 3 : 4-benzpyrene, and the information that these abnormal cells, by reproduction, gave rise, in the absence of the agent and indefinitely, to abnormal races showing widely varying polymorphism, like the cells of tumours.

Since then, similar races of abnormal Paramecia and other Ciliates have been produced by suitable exposure to the following blastogenic agents: cyclic hydrocarbons, gamma and ultra-violet radiations, heat, cold and hypertonic dextrose.



NOS. 1, 2 AND 5 ARE SPECIMENS FROM THE INFECTED CULTURE STAINED BY FEULGEN'S METHOD; THE NUMBER OF PARTICLES PER UNIT AREA IS APPROXIMATELY CORRECT; IN No. 1 THE MICRO-NUCLEUS (*mi*) IS UNSTAINED; IN No. 2, WHICH IS A DOUBLE, ONE IS UNSTAINED AND THE OTHER FAINTLY STAINED; No. 5 IS A DOUBLE MONSTER; No. 3 IS A NORMAL WELL-FED ORGANISM STAINED FEULGEN; No. 4 IS AN INFECTED CELL STAINED GRAM AFTER FORMALIN VAPOUR FIXATION, IT SHOWS INCLUSION BODIES AND DUMBELL CRYSTALS (c); No. 6 IS A NORMAL STAINED INTRA VITAM WITH CRESYL BLUE, IT SHOWS FOOD VACUOLES, CRYSTALS AND BLUE VACUOLES (*bv*).

The possibility that a virus might be playing a part has been kept in mind; nothing suspicious was noted until a few weeks ago. In a culture of Aspidisca sp. subjected to 40° C. for one minute, abnormals were sought for; they occur for 24–48 hours after such an exposure. None was found, as is often the case, since they are always of rare occurrence. In the culture, six days later, I was astonished to see many abnormals, far more numerous than ever seen before. Some were picked out and stained by Feulgen's method; they showed in the cytoplasm, collections of minute stained particles, similar to virus inclusions (see accompanying figure).

These inclusions are easily distinguished from food vacuoles containing bacterial debris shown in Nos. 3 and 6. It may be mentioned that organisms fed on Gram positive Staphylococci do not show Gram positive cocci in the food vacuoles: they become Gram negative. The inclusions appear to lie free in the cytoplasm and not within a vacuole. They have never before been found in Aspidisca, either in normals or in abnormals produced by blastogenic agents.

The infected culture was sub-cultured to many well slides, under conditions known to favour abundant growth. Instead of reproducing, they ceased to divide and gradually died out, all being dead on the twenty-second day. Many attempts to infect normals and cells subjected to blastogenic agents were unsuccessful.

Two other facts are worth recording. Accompanying the presence of abnormals in the infected culture, were seen all the signs of increased cytoplasmic viscosity which has invariably been observed preceding the production of abnormals by blastogenic agents. There is, therefore, a similarity in the reaction of the cells to virus and to blastogenic agent. I also noted that in many cases, the micro-nuclei failed to be stained by Feulgen, see Nos. 1 and 2; perhaps the supply of nucleic acid to the micro-nuclei is interfered with, being all grabbed by the virus; in these specimens one also sees unstained bands, see No. 1, in the macro-nucleus as though it, too, was deprived of nucleic acid.

I would be very grateful for any information on virus or virus-like inclusions in the Protozoa.

J. C. MOTTRAM.

Mount Vernon Hospital,
Northwood,
Middlesex.
March 3.

[1] NATURE, 145, 184 (1940).

Palæochemistry of the Ocean

A QUANTITATIVE account of oceanic palæochemistry depends largely on the theory accepted for the origin of the ocean, especially for its halogen content. Yet with any tenable view, useful limits for biological consideration can be established for such quantities as the total salinity at the beginning of the Cambrian period. The K/Na ratio of the original ocean can also be stated with some confidence, when we consider that the mean composition of igneous rock has not appreciably changed over the oceanic age.

The original K/Na ratio of the ocean. The speculations of Macallum[1] on the origins of the cellular potassium, and the vogue they have obtained, makes this question of some interest to the biologist. According to Macallum, potassium was more concentrated than sodium in the primitive ocean (the K/Na ratio being about 2·0) and the cell to-day with more potassium than sodium tends to repeat in an altered environment a primitive adaptation. As evidence for the higher potassium concentration he cites analyses of Reindeer Lake and Churchill River[2] situated in the zone of Archæan rock in Canada. Against this there is the Ottawa River[3], in a region of similar rock with a K/Na ratio less than unity (0·64). The Hayes and Nelson Rivers[4], draining wide areas of Archæan as well as later sedimentary strata, have a K/Na ratio of 0·32 and 0·16, which are *less* than the total river average of 0·37[5]; and the Mahanuddy, which in India drains a wide area of Archæan rock, has a K/Na ratio of only 0·28[6].

Occasionally, high K/Na ratios may be found in rivers and lakes not associated with crystalline or Archæan rock, for example, in the Würmsee and Königsee[7] (Macallum cites such as evidence for his view when it is clearly against it); and the potash lakes of Nebraska[8] occur, too, in regions where there is no outcropping of igneous or Archæan formations.

At the same time there is no apparent reason why potassium should be higher than sodium in the early seas, since the K/Na ratio in igneous rock is 0·92, and whether we consider the action of neutral or very weakly acidic rain, or of hydrochloric acid, potassium is not more readily dissolved from the rock than sodium. It is dissolved less readily. This may be proved from Merrill's studies[9] of rock weathering, from the mean analyses of rivers draining igneous rock, and from Taylor's laboratory experiments[10] with hydrochloric acid.

Occasional high K/Na values are simply explained by a *local* preponderance in the rock of potassium compounds such as orthoclase, leucite, or biotite.

Oceanic salinity at the beginning of the Cambrian period. Whether we suppose the oceanic chloride to have been present almost entirely in the original atmosphere of a cooling earth, or to have originated as meteoritic chloride of iron, or again to have condensed along with the water of the ocean from volcanic emissions, the total ionic content will not change greatly, if at all, from its value at the outset. Only on one theory of the origin of the ocean, in which the chloride, but not the water, has been entirely supplied from volcanoes, does it alter from something like lake water to its present composition.

With such a theory and a consideration of the relevant data it may be shown that the salinity at the beginning of the Cambrian age was about 1·6–2·0 per cent. In this estimate account is taken of the changing relation of igneous to sedimentary surface, of the different proportions of sodium to sediment in water draining igneous and sedimentary rock; and it is also assumed that the total depth of the pre-Cambian strata is 40 per cent of the whole sedimentary depth, which would appear to represent approximately the current view. Even if we reduced the figure to 25 per cent the salinity at the beginning of the Cambrian period would still be 1·2–1·6 per cent. Equating, therefore, the salinity of mammalian blood (about 0·9 per cent) with that of the Cambrian ocean, in which Protovertebrates may have first appeared, is a speculation not supported by the geochemical data. This, however, does not militate against the view that the ratios of the inorganic ion concentrations in mammalian plasma may have broadly an oceanic significance (Bunge[11]; Quinton[12]).

A more detailed consideration of such questions will be submitted to the Royal Irish Academy.

E. J. CONWAY.

University College,
Dublin.
March 7.

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Control of the Kromnek (Spotted Wilt) Disease of Tomatoes

IN many seasons the kromnek disease causes heavy losses in both tobacco and tomato in the Cape Province and Transvaal. Its virus origin was first diagnosed[1] in the Kat River area of the eastern Cape Province, and it has since been identified with the spotted wilt disease now well known in many parts of the world. In the Kat River area it is transmitted mainly, if not entirely, by the feeding of a thrips (*Frankliniella schultzei* Trybom) which has a wide host range among both wild and cultivated plants.[2] The virus likewise attacks a very great variety of plants[3] and the control of the disease is therefore a very difficult problem which has not so far been solved for South Africa.

Tartar emetic is used effectively against the citrus thrips in America, and preliminary trials with it at this laboratory have given very promising results with regard to the control of kromnek in tomatoes. The formula used was the same as that advised for citrus thrips, namely, 1 lb. tartar emetic plus 2 lb. sugar to 100 gallons of water. Spraying was started in the outdoor seed-bed in October when the seedlings were still in the cotyledonary stage and were already being attacked by the disease vector; it was repeated frequently during the subsequent nine weeks. Control beds a few yards away were left unsprayed;

at a height of four inches they developed the symptoms of kromnek and became 100 per cent infected, growth immediately coming to a standstill. An outstanding contrast was offered by the sprayed beds, which showed vigorous healthy growth, not more than 5 per cent of the plants becoming diseased. Those left in the beds after thinning yielded a bountiful crop.

Spraying of transplanted tomatoes gave promising results, in view of the very small scale of the tests and of the consequent continuous invasion of insects from the unsprayed rows to the trial rows adjoining.

E. S. MOORE.

The Laboratory,
Balfour, Cape Province,
South Africa.
Feb. 13.

[1] Moore, E. S., Science Bull. 123, Dept. Agric. Union of South Africa (1933).

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Inactivation of the Causative Agent of Fowl-Leukosis by X-Rays

THE following is a report on the inactivation of the causative agent of fowl leucosis (hæmacytoblastosis, Strain *T* Engelbreth-Holm) by means of X-rays.

The method used was as follows: blood was withdrawn from the animal at the height of the infection, with the addition of sodium citrate. A drop of this blood was placed on a concave slide, covered with a mica coverslip 0·03 mm. thick and made air-tight with paraffin. Blood drops mounted in this way were irradiated. After irradiation every drop was diluted with 2 c.c. of Ringer's solution, and 1 c.c. of the diluted blood was inoculated intravenously into a fowl. Altogether six series of experiments were carried out on thirty-four fowls. Control experiments were made for each series with non-irradiated blood.

Irradiation was carried out by means of a demountable X-ray tube with copper anode operated on a vacuum pump at a tension of 35 kv. and a current of 30 ma. The intensity of the X-rays was about 105,000 r./min. at the distance of the irradiated subject. According to absorption analysis the overwhelming part of the radiation used consisted in characteristic *K*-rays of the anode material (copper). The half-value layer in aluminium was 0·053 mm. The results are given in the accompanying table.

Leucotic virus is destroyed with certainty by a dose of 4,000,000 r.; 2,000,000 r. has no effect. When 3,000,000 r. is used results vary. We obtained three negative results against two takes; both the latter showed an anæmic form of hæmacytoblastosis.

X-ray dose in million r.	No. of chicks injected	Successful injections	Unsuccessful injections
½	2	2	0
1	2	2	0
2	4	4	0
3	5	2*	3
4	11	0	11
5	6	0	6
6	4	0	4

* Anæmic forms.

The doses used by us for inactivating the agent of fowl leukosis lie in the same range as those used for inactivating the few viruses of which the resistance to irradiation has been determined. The inactivating dose for fowl plague virus is 3,000,000 r. (Levin and Lominski[1]), for infectious papilloma of the rabbit 3,000,000 r. (Lacassagne and Nyke[2]), for vaccinia somewhat more than 3,900,000 r. (Gowen and Lucas[3]). The doses used by us for inactivation are many times larger than those employed hitherto in attempts to influence the leucotic agent, and this is undoubtedly the reason for the negative results obtained by Engelbreth-Holm and Rothe-Meyer[4], by Forfota[5] and by Jarmai[6].

This work has been aided by a grant from the Lady Tata Memorial Trust.

L. DOLJANSKI.
G. GOLDHABER.
M. PIKOVSKI.

Department of Experimental Pathology
and the Radiological Department
(Cancer Laboratories),
Hebrew University,
Jerusalem.
Feb. 2.

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Diffuse X-Ray Reflexions

FOLLOWING the observation by Sir William Bragg that diffuse scattering takes the form which it should have if it were due to diffraction by small groups of atoms within a crystal (as originally suggested by Preston), Prof. G. E. M. Jauncey[1] has obtained a formula giving the resulting positions of the diffuse spots for small values of $(i - i_B)$, i being the glancing angle of incidence on the set of crystal planes for which i_B is the Bragg angle. He expresses astonishment that this formula is identical with those deduced by Zachariasen and by Raman and Nath, each on very different assumptions. Mr. G. D. Preston[2] has pointed out that this formula is an approximation to the formula given by Faxén in 1923, and stated that the physical interpretation of Faxén's formula is that the surfaces of constant intensity surrounding the Bragg points are spheres. This, however, is again *only true when* $(i - i_B)$ *is small*.

The reason why all these different assumptions (for example, existence of small groups, waves of the Raman type or elastic heat waves) give the same formula for small values of $(i - i_B)$ is that in the derivation of each formula it is implicitly or explicitly assumed that the spreading of the intensity of reflecting power around each reciprocal lattice point is independent of direction. Consequently, the formulæ are simply a geometrical way of expressing

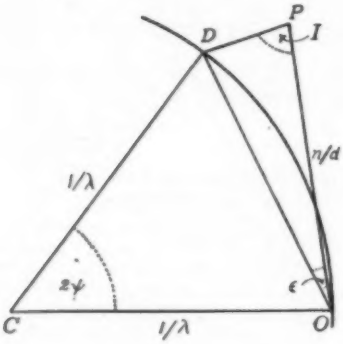
the fact that *near* the reciprocal lattice points the distribution may be taken as spherical.

Raman and Nath's more general formula

$$d \sin \psi \sin (I - \varepsilon) = n\lambda \sin I$$

is also only a *purely geometrical relationship* connecting the centre C of a sphere with two points O and D on its surface and one point P not on the sphere (P not necessarily in the plane of C,O,D). Faxén's formula applies to the special case where C,D,P are collinear.

Without detailed experimental information, the physical interpretation to be applied to such a general formula is largely a matter of choice. Part of the information required, of course, is precisely that



referred to by Preston, namely, the shape of the surfaces of isodiffusion (expression due to J. Laval), particularly when $(i - i_B)$ is *not* small. Such experimental observations, made in this Laboratory, show quite definitely that in general these surfaces are *not spherical*. For diamond, indeed, the reflecting region around the (111) reciprocal lattice point has been shown to possess six horns pointing along the six [100] directions[3]. Unfortunately, however, even this information is not enough. M. v. Laue[4] has shown, for example, that for a finite crystal of octahedral shape, the reflecting region around a reciprocal lattice point has eight horns, but either wave theory will lead to similarly shaped regions provided that along certain crystal directions the atoms tend to remain always in phase.

The experimental information most to be desired at present is that relating the surfaces of isodiffusion for various reciprocal lattice points (to be experimentally determined) with other physical properties of the crystal, such as temperature, perfection, elasticity coefficients, and so on. Work along these lines is now in progress, but it is clear that the subject opens up a very wide and fascinating field of research.

K. LONSDALE.

Davy Faraday Laboratory,
Albemarle Street,
London, W.1.
March 27.

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A Property of Conjugated Systems

IN a compound of the type $X.(CH = CH)_n Y$, the conjugated system is an electronic conductor between the covalent groups X and Y, and there must therefore be a correspondence between such chemical properties of the compound as leave the conjugated system intact and those of the covalent compound $X.Y$. This generalization has been recognized in the particular case of carbonyl compounds, but its wide value as a very general means of insight into the reactivity, as well as the mechanism of reactivity, of the compound $X.Y$, seems to have been overlooked.

The most readily available conjugated systems are those of *ortho-* and *para*-benzene derivatives, and the generalization at once disposes of the old supposition of a fundamental contrast between aromatic and open-chain chemistry. Nevertheless, the possibility of nitrating paraffins which, in this light, follows from that of nitrating alkyl benzenes, has only latterly been realized and put into technical operation. This example also serves to illustrate the efficacy of the aromatic resonance in promoting reactivity, a factor which must be allowed for in applying the principle. Although it is for this reason safer to deduce the behaviour of XY from that of the conjugated compound than to do the reverse, nevertheless it is clear that the possibility of chlorinating or nitrating XH to $X\,Cl$ or $X\,NO_2$ can provide a criterion of the ortho-para directive effect in aromatic substitution.

Again, the mechanism of *para*-nitrosation of dimethyl aniline must be reproduced in that of dimethylamine, and it is obviously not permissible to regard the latter as involving the salt of the base if, as is accepted, the former involves the free base. The widely accepted view, based on the results of kinetic measurements[1], that nitrosation and diazotization involve the salts of bases, is therefore untenable; the function of the protons, which such measurements show to participate in the reaction, must therefore be to activate the nitrous acid. It is, however, hoped to show in a fuller discussion of this reaction that other reasons independently point to the same conclusion.

The principle also constitutes a bridge between organic and inorganic chemistry, of the more value because in the latter the study of reactivity and mechanism is little advanced. Thus the mode of oxidation of hydrogen peroxide, hydroxylamine, and hydrazine respectively must correspond to those of hydroquinone, *p*-aminophenol and *p*-phenylene diamine. The *o-p* nitration of chlorobenzene must be reflected in that of hydrogen chloride, which doubtless represents the first stage in the familiar formation of nitrosyl chloride and chlorine. The nitration of aniline (as acetanilide) shows that, as indeed Franchimont[2] surmised, nitramide is an intermediate in the preparation of nitrous oxide from ammonium nitrate; similarly, the formation of nitrogen from ammonium nitrite is, as has also been shown kinetically[1], a case of diazotization.

J. KENNER.

College of Technology,
Manchester, 1.
March 28.

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RESEARCH ITEMS

Stimulation of Algal Growth by Ultra-Violet Radiation

THE research on this topic, which has been progressing for some time at the Smithsonian Institution, has produced results of considerable interest, and the recent contribution by F. M. Chase (*Smithsonian Misc. Coll.*, 99, No. 17) promises to be of importance in some aspects of the physiology of development. Cells of the alga *Stichococcus bacillaris* exposed repeatedly to the stimulative action of four wave-lengths of the ultra-violet grow much more rapidly than do the controls. Four successive irradiations at 2352 A., for example, stimulate the cells to a growth-rate (as measured by cell number) of 4·7 times the controls. This stimulation is of the same order for the first irradiation by all four wave-lengths employed (2352 A., 2483 A., 2652 A., 2967 A.), but in general the additional stimulation on further irradiation is the less marked the longer the wave-length. The interesting point about this stimulation is that the enhanced growth-rate leads not only to a decrease in cell length, as might be anticipated, but also to a somewhat increased cell breadth. The volume relations are more complex. On first stimulation the volume of a cell is greater than controls for all four wave-lengths, and on second stimulation for the two longer wave-lengths. With the very rapid multiplication which occurs at the shorter wave-length the volume soon falls below that of the controls. The changes which thus occur in the appearance of the cells, and these are quite striking judging from the published photographs, are permanent. The irradiated cells are also changed somewhat in internal organization, for they are now less sensitive to lethal exposures to ultra-violet than are untreated controls.

Coco-nut Disease in Jamaica

THE rapid destruction of coco-nuts in the western end of Jamaica is now considered to be due to bronze leaf wilt (F. M. Bain, *Bull.* 22, Dept. Sci. and Agr., Jamaica, 1940). As well as producing characteristic leaf symptoms, the disease also results in a dropping of the nuts. Unsatisfactory conditions of water supply within the plant tissues are held responsible for the pathological symptoms observed. Affected plants may show a progressive dying back during several seasons with eventual mortality, or, as may also happen, the plant may die suddenly. Both types of the disease are related to conditions of moisture deficiency, and are referable to the details of root distribution, root mortality, soil type, and soil moisture relationships—on all of which points the author has advanced new and interesting data. It is possible, for example, to make a working classification of the soil types and characteristics on which wilt disease may be expected to occur. From such considerations the author reaches the conclusion that the application of curative measures in the field is impracticable, except in areas where affections of the progressive type are still in an early stage. Preventive measures also present serious difficulties, including the economic aspect, and in some instances direct attention to the need for securing alternative paying crops. Drainage, irrigation, trenching, mulching, manuring and spacing may each and all, in suitable circumstances, be expected to afford some alleviation of this type of wilt.

Development of the Seed in Angiosperms

R. A. Brink and D. C. Cooper (*Bot. Gaz.*, **102**, 1–25; 1940) have studied the histology of double fertilization and its effect on the developing embryo of alfalfa. They show that 34·4 per cent of fertile ovules abort within 144 hours after self-pollination, whereas only 7·1 per cent abort after cross-pollination. This abortion is due to the inability of the endosperm to keep pace with the growth of the surrounding tissues. The embryonic cells increase in an arithmetical progression, whereas the nuclei of the endosperm are without cell walls and increase geometrically during this period. The rate of growth of endosperm after cross-fertilization is significantly greater than after self-fertilization. Statistical data on the development of the embryo and endosperm are provided and the role of double fertilization in seed formation is discussed. The physiological advantages of double fertilization in angiosperms and the evolutionary connexion between incompatibility, heterosis, double fertilization and cross-pollination are pointed out.

Œnothera cantabrigiana

B. M. DAVIES (*Genetics*, **25**, 433–437; 1940) found plants in the Cambridge Botanic Garden which were similar to *Œnothera biennis* but which had red anthocyanin pigmentation on various parts. Cytogenetical analysis showed that these plants gave *laeta* and *velutina* forms in the same way as *biennis*, but in place of *rubens* being given by the pollen and *albicans* by the pollen as in *Œ. biennis*, these are given by the egg and pollen respectively in *Œ. cantabrigiana*; the pollen and egg lethals have crossed over.

Heterosis

A FURTHER contribution to the problem of heterosis has been made by work on the tomato by E. S. J. Hatcher (*Ann. Bot.*, N.S., **4**, 735–765; 1941). There are high correlations between number of seeds in the fruit, weight of seed and fruit weight. Size heterosis appears at the stage of differentiation of the cotyledon primordia in the embryo. Embryo size at maturity is largely influenced by the maternal tissue, therefore reciprocal hybrids may have different embryo sizes. After germination, the cotyledons but not the plumule-meristem show heterosis in the hybrids. It is shown that embryo size is in no way determinate—indeed heterosis only becomes obvious after the flowering stage, while seeds of the same genotype which differed considerably in weight gave rise to plants of uniform size. The author therefore supports the theory of Jones involving complementary action of dominant factors.

Metamorphism in New Zealand

AN early Palæozoic geosyncline appears to have occupied the greater part of Otago in the south of New Zealand, and in it was deposited a thick series of quartzo-felspathic sediments, interstratified with other types and with contemporaneous basic volcanic rocks. Probably in Permian or early Triassic time these rocks were folded and subjected to regional metamorphism. The details of this metamorphism on the rocks of an area of about a thousand square

miles in the Lake Wakatipu region of Western Otago have been thoroughly investigated by C. O. Hutton, whose results have recently appeared (*Geol. Mem. N.Z. Dept. Sci. Ind. Res.*, No. 5, pp. 84 + 17 plates; 1940). The region furnishes an excellent example of progressive metamorphism within the chlorite zone, which has been subdivided into four subzones based on textural criteria and the degree of reconstitution suffered by the rocks of greywacke composition, which are here dominant. Subzone 1 is represented by slightly altered greywackes with lack of foliation. In 2 foliation appears, the rocks are semi-schists, and clastic grains are much reduced in size and number. As the isograd between 2 and 3 is reached, reconstitution becomes more complete and the clastic grains disappear. The rocks of 3 are perfectly schistose and include quartzo-felspathic schists and albite-epidote-chlorite-schists. The major part of the area falls into subzone 4, the rocks of which are characterized by a marked increase of grain size and of coarseness of foliation. In the associated green schists greenish biotite becomes abundant, but the red-brown variety of the biotite zone is not developed. The types derived from greywackes have quartz and albite as the dominant minerals, generally accompanied by epidote with chlorite or actinolite. The memoir is well illustrated and the petrographic descriptions are supported by many new chemical analyses.

The Shallowater Meteorite

THE meteorite of this name was found near Shallowater, Lubbock County, Texas, in 1936, the weight of the stone being 4,750 gm. It is an extremely coarsely crystalline aubrite composed of 81 per cent of enstatite, 5 of fosterite, 2 of oligoclase, 9 of nickel-iron, 1·5 of troilite and 1·5 of miscellaneous constituents (W. F. Foshag, *Amer. Min.*, 779–786; December 1940). A remarkable feature of the magnesium silicate minerals is their practical freedom from iron. The enstatite occurs as lath-like crystals up to 4·5 cm. long arranged in a coarsely reticulating texture. This fact, together with the lack of any evidence of the derivation of the enstatite from a monoclinic form, and the occurrence of olivine as grains in the enstatite, suggests to the author that the stone may be a product of direct crystallization from a magma, and not an accumulation of crystals from a magma of different composition. A more serious difficulty in interpreting the mode of origin of the stone is the association of nickel-iron and troilite (FeS) with iron-free silicates that normally contain iron. It is hard to believe that there was such an extraordinarily fine balance of the oxygen supply during crystallization that there was just sufficient to satisfy the magnesium and none available for any of the iron, particularly as the peculiarity is shared by other aubrites. On the other hand, there are indications that the nickel-iron and troilite may have been later introductions. Evidently this problem of the relation of nickel-iron to silicates in stony meteorites requires serious attention.

Tin Research

THE art of coating metals with tin by dipping them into the molten metal is one of considerable antiquity, and this method of tinning, known as 'hot-tinning', is still the most widely used. In recent years there have been considerable advances in the method of electro-deposition, but it may be said that the two processes fall into two distinct categories. By the hot-tinning process bright lustrous coatings up to 0·001 in. in thickness may be obtained and they do not tarnish readily. Electro-deposited coatings may be of any desired thickness but are matt when they emerge from the plating bath and give only a satin finish when polished. The hot-tinning process depends on experience and personal skill, and laboratory control is not necessary. As a result, the process has been neglected by research workers. Literature and technical data are very scanty and it is therefore very timely that a book should have been issued by the Tin Research Institute, Greenford (Publication No. 102: "Hot-Tinning" by C. E. Horner. Pp. 28) dealing with the processes used in hot-tinning fabricated articles of various kinds but not including the manufacture of tinplate or the continuous tinning of strip or wire. After describing the preliminary processes of degreasing and pickling, the book discusses the various types of tinning baths, their operating temperatures and their maintenance in continuous operation. Much of the value of the publication lies in the explanations given of the advantages associated with the different processes, of the causes of blemishes, of the conditions which influence the brightness of the coating and other practical points. Its contents are based on the experience and information accumulated by the Institute over a number of years and on the experimental work carried on in its laboratories. Although only a brief review of the subject, the directions given on the hot-tinning of articles of steel, iron, copper and copper alloys will be found of the utmost practical value.

Figures of the Earth and Moon

A PAPER on this subject by Harold Jeffreys (*Mon. Not. Roy. Astro. Soc.*, **101**, 1) is supplementary to a previous paper which appeared about four years ago (*Mon. Not.*, **97**). Immediately after the publication of the latter paper, E. W. Brown published a correction to the solar contributions to the motions of the moon's node and perigee, and this necessitated certain corrections to the determinations by Jeffreys, which were given in a revised solution (NATURE, **139**, 471; 1937). Jeffreys has also made a new discussion of the observations of gravity over the surface of the earth and has attempted to determine the harmonics of low order other than the main elliptic term (*Mon. Not. Geophys. Suppl.*, **5**, 1). While there is good evidence that some harmonics other than the main ellipticity term are present, "the data are not adequate to separate them, mostly on account of the lack of data for the South Pacific and high southern latitudes". The new estimate of the main ellipticity term in gravity contains an uncertainty because it rests on a hypothesis of randomness which will require further check. Jeffreys has made a complete new solution, in the first paper referred to above, for the constants involved, and the results are considered satisfactory. A difficulty arises in the disagreement between the moon's dynamical and visual parallaxes. Lambert has shown (*Astrophys. J.*, **38**, 181–5; 1928) that the dynamical parallax exceeds the visual by 0·16″ if the ellipticity is taken as 1/297, and agreement is reached if it is taken as 1/293·5, but it is suggested that the discrepancy may be due to an abnormal deflexion of the vertical at Cape Town.

CRYSTALS AND PHOTONS

IN his presidential address to the Indian Academy of Science, Sir C. V. Raman surveyed recent progress in the investigation of those phenomena which are observed when radiation is scattered in a crystal (*Current Science*, January 1941. Supplement). The subject is a natural extension of the well-known Raman effect usually observed in liquids, which has proved such a fruitful source of knowledge concerning molecular vibrations.

The analogous effects observed in crystals are, according to Raman and his collaborators, the result of interaction between the incident radiation and the material particles of the crystal. As a result of the absorption of energy from the incident beam, the regular geometrical array of atoms or molecules in the crystal is set into vibration. The lattice waves in the crystal can then be regarded as stratifications of density which may reflect the energy preferentially in certain directions. Owing to the interchange of energy between radiation and matter, the reflected ray suffers a change of wave-length. Thus when a diamond is illuminated by monochromatic radiation, the scattered ray contains two components with wave numbers differing by $\pm$ 1332 cm.$^{-1}$ from the wave number of the incident ray. This change of frequency appears on the quantum theory as the result of an exchange of energy between a photon and the crystal, a diminution occurring if the photon is the donor and the crystal the acceptor, an increase if the reverse is the case.

In the experiment just described, the radiation is scattered in all directions from the crystal; but Sir C. V. Raman also envisages circumstances in which the incident radiation is regularly reflected in certain directions. He states that infra-red radiation, within a certain range characteristic of the material, is strongly reflected backwards by the crystal because the optical vibrations of the lattice are powerfully excited by the incident waves. Recently, the observation of similar phenomena has been extended to the range of X-ray frequencies. According to Raman, the optical vibrations of the lattice, excited by the incident X-rays, create dynamic stratifications of the electron density, and these give regular reflexion of X-rays with a change of frequency in much the same way that the static planes of atoms give the classical Bragg reflexions without change of frequency.

These ideas are obviously of great interest, especially with regard to the reflexion of X-rays. This part of the subject has received considerable attention in both Europe and the United States. Reference to the correspondence columns of NATURE in the last year or two shows that the X-ray phenomena which Raman describes have been ascribed by other investigators to reflexion from the thermal waves in the lattice. The difference in point of view seems to be that Raman considers the lattice waves to be a result of excitation by the incident energy, and he also postulates a frequency change in the scattered energy. His case would be greatly strengthened by direct observation of this frequency change, which is, unfortunately, too small to be detected at present. The other approach to the problem regards the lattice waves as being already present in the crystal as a result of the thermal vibrations of the atoms, and the observed effects do, in fact, appear to be explicable on these lines. Whether a quantum mechanism is necessary for an accurate description of the phenomenon would seem to be a matter for still further investigation (see also p. 467 of this issue).

DAMS AND THE PROBLEM OF MIGRATORY FISHES

THE special symposium issue, with the above title, of the *Stanford Ichthyological Bulletin*, published through the co-operation of the Fish Commission of the State of Oregon and the Natural History Museum of Stanford University, comprises a number of papers read by leading fishery authorities in the United States on the problem presented by the construction of dams for generating electric power and for irrigation of agricultural land in certain States on the Pacific seaboard of North America.

The dams in question—already constructed or to be constructed—are in the basins of the Columbia and Sacramento Rivers. The fish mainly affected are the anadromous Pacific salmon (Oncorrhyncus)—chinook, blue back and cohoe—and the steel-head trout; fish which are of great importance in connexion with the world-famed commercial fisheries of the North American Pacific coast. Consideration has had to be given to the question of the effect these dams will have not only on the ascent of the breeding fish to their customary spawning grounds (and on the spawning grounds themselves) but also on the descent of the fry (and spent adults).

Fundamentally, a proposition of this nature resolves itself into the formulation of two questions, namely, (*a*) are such industrial developments on a river compatible with the continued maintenance of the fisheries in that river, and (*b*) if the answer is in the negative, are the fisheries to be regarded as of secondary importance and therefore inevitably to be sacrificed—the issue being the relative merits of each *quâ* progress? A subsidiary question will be the cost of the necessary measures involved under (*a*) to safeguard the fishery interests. If the cost is high it may be urged that the proposition really comes under heading (*b*).

At the outset neither of these questions seems to have even suggested itself to the industrial interests bent on exploiting these rivers as power generators. Nor does it appear that the central authorities vested with the power of supervisory administration (and whose consent had to be obtained in the first instance) were any more alive to the situation and to its implications. It devolved upon the fishery interests, through the American Bureau of Fisheries, to direct attention to the probable effect on the fisheries and to the very considerable monetary value to the community at large of those fisheries. Inciden-

tally, these schemes were apparently initiated in connexion with the relief of unemployment.

In the Columbia River system four of the dams are either already constructed or in process of being constructed; and there are nineteen others contemplated. In the Sacramento River two are constructed, or nearing completion, and the erection of fourteen others is under contemplation. The heights of two of these are mentioned, namely, at Grand Coulee on the Columbia River, 350 ft., and at Shasta on the Upper Sacramento River, 560 ft. The United States fishery experts are therefore obviously confronted with a problem of exceptional magnitude. How they are proposing to tackle it is set out in the symposium.

As regards the Grand Coulee Dam alone, which is going to eliminate some 600 miles of main river and 530 miles of tributaries as breeding ground, it is estimated that the runs of fish involved represent an annual value of an investment amounting to a capital outlay of 11,000,000 dollars yielding 4 per cent (or approximately £88,000 per annum), this area representing apparently about one third of the total catchment area of the Columbia River.

Grand Coulee Dam is 350 ft. in height; and the fishery experts have reached the conclusion that any measures devised to facilitate the ascent of fish to the waters above would cost at least 2,000,000 dollars "with a very good chance that they would not work". These measures, moreover, would be irrespective of what would have to be done—if practicable—to safeguard the downward migrating fry and spent fish (in this case the spent fish would be only among the steel-head trout, as all the so-called salmon of the Pacific die after spawning once).

The only alternative presenting itself was to divert the fish that would normally spawn above the site of the dam to tributaries entering the river below, where they would be held until ready to spawn, the intention being to let the fish spawn in the natural way in the spawning grounds previously investigated and regarded as probably suitable and adequate. The means adopted to secure this diversion, the difficulties and expense involved, are described.

The diversion had to be effected by actually transporting the fish from a dam (of surmountable dimensions) lower down. The fish were deposited at the mouth of the stream draining the tributary system selected (which was racked to prevent them dropping down stream), but unfortunately the fish failed to proceed upstream to the appointed place. Accordingly they had to be transported to where it had been intended they should go, and where they were retained until ripe eventually for stripping, the ova being fertilized and hatched artificially and the fry distributed over the selected rearing grounds.

It is, as yet, by no means certain that success will attend these efforts. Whether the available rearing ground will prove adequate for the quantity of fry released, and if so whether the returning adults resulting therefrom will be disposed to find the same streams where they were reared as fry, or whether they also will have to be diverted by actual transportation as were their progenitors, remains to be seen.

In the Sacramento River system the problem seems to be an even harder one. Here the embankment of the dam being constructed will be 560 ft. in height. It will impound the waters not only of the upper third of the Sacramento River itself but of the whole of the McCloud and Pit Rivers, permanently cutting off some 112 miles of previously available spawning and rearing ground.

In view of its cost and its problematical practical value when constructed—having regard to the height to be surmounted and to the seasonal fluctuations of the surface water-level (amounting to upwards of 200 ft.)—the idea of a fish pass had to be abandoned. There remain the alternatives of either diverting the fish to other still available spawning grounds in tributaries entering the main river below the dam or, after collecting the spawners, hand stripping the fish and sowing the fry in waters where they would have a chance of developing and from which they could migrate downstream without danger to themselves. From previous counts that have been made of the runs of fish going up past the site of the Shasta Dam it is estimated that in the case of the second alternative a total of approximately 100 million ova would have to be handled, "a number greater than that which is now produced by all the federal salmon hatcheries".

Schemes of this magnitude are not (and are never likely to be) encountered in Great Britain. There are, however, a number of impounding dams in England and Wales and (as yet not so many) in Scotland for the storage of water required by townships for domestic and industrial purposes. These are mainly in the headwaters of rivers, and though considerably less in height and dimensions than those which are the subject of discussion in the symposium under consideration, the problem they have presented has points in common.

The dams themselves are, of course, quite insurmountable by ascending fish and, because until recently the technique of dealing with the fluctuating surface-level of the reservoirs created by the dam had not been grasped, the notion of a fish pass to enable the fish to get up had been more or less dismissed. In any event the consequent extensive flooding of country above the dam so reduces the available area of spawning and rearing ground that the cost of a fish pass was deemed to be scarcely worth while. Moreover, the question of the descending fry and spent fish remained unsolved owing to the fluctuating top-water level of the reservoir and consequently to the uncertainty as to where, when and how egress could be found for them.

The difficulties presented as regards the ascent of the breeding fish and the subsequent descent of the fry and kelts have now to some extent been met by the idea of a fish pass with an adjustable feed from the reservoir, as has been adopted at Tongland (where the range of fluctuation in the top-water level does not exceed 41 ft.) and at the other impounding reservoirs on the same river system (the Kirkcudbright Dee) which are comprised in the Galloway Power Scheme.

At Tongland a large proportion of the fry pass through the turbines apparently without serious harm. The remainder, together with the spent fish, eventually find their way to the fish pass intake. The Tongland dam is 72 ft. in height and is the lowest situated of the series of dams, being immediately above the tidal water. It was, therefore, of vital importance to make it surmountable if the salmon of the Dee were not to be exterminated. That the measures taken to that end have been successful is apparently the case, and it can be assumed that the similar measures at the other dams above have been equally successful.

Though Tongland and its associated dams store water for power and not for distribution, the principle involved is the same as that applying to large im-

dounding dams generally. In each case there is the problem of assisting the fish (descending as well as ascending) over or round the dam, complicated by the fact that the top-water level of the reservoir varies according to meteorological and seasonal conditions.

An additional problem presented by, and peculiar to, the impounding of water for generating power, as distinct from supply, is the draw through the turbines. If there is adequate clearance between the blades, and the revolutions per minute do not exceed a certain—as yet not fully determined—maximum, small fish, such as smolts, can pass through, as they do at Tongland (and elsewhere) without hurt. It is probably better to let these small fish avail themselves of a quick exit from the reservoir by this, usually more readily found, route rather than compel them, by the interposition of closely interspaced gratings at the turbine intake, to seek it after probable delay through the fish pass intake. Screened, but by a grating with relatively wide interspaces, the turbine intake must be, however, to prevent the larger adults, spent and dropping downstream as kelts, from getting involved in the turbines, with certainly fatal results—to the fish.

It might be supposed that what has been possible on the Dee at Tongland would be equally possible on the Columbia and Sacramento Rivers. The magnitude of the proposition on the latter rivers, however, removes it to a somewhat different category. On no single river system in Britain has it been nor is it likely to be, necessary to contemplate an overflow at any dam amounting to as much as 650,000 cu. ft. (as at the Grand Coulee on the Columbia River), or an annual catch of salmon exceeding 1,500,000 lb. (as is the case in regard to one commercial fishery alone at the mouth of the Sacramento River).

It requires no exceptionally acute imaginative faculty to realize that the problem in these Pacific coast rivers is on a scale which introduces a somewhat different standard of outlook and demands a special mode of treatment.

The fight of the fishery interests to prevent the extermination of these important and valuable fisheries will be watched with sympathetic interest.

THE INTERNAL COMBUSTION ENGINE

THE full text of the series of three Cantor Lectures of the Royal Society of Arts delivered by Prof. S. J. Davies under the title "Recent Developments in Internal Combustion Engines", is now available (*J. Roy. Soc. Arts*, Feb. 1941).

In his opening remarks Prof. Davies quoted the prophecy made by Sir Frederick Bramwell at the jubilee meeting of the British Association in 1881 with respect to the steam engine: "I very much doubt whether those who meet here fifty years hence will then speak of that motor except in the character of a curiosity to be found in a museum"; such was the overwhelming opinion he had formed regarding the internal combustion engine. While the steam engine, including the steam turbine, has found success in certain definite fields of application, as has its rival in others, it cannot be denied that the internal combustion engine has, due to its special advantages, opened up fields of application, not closed to but only remotely accessible by the steam engine. Of these the highest is that of aeronautics, in which the present-day performance of the engines in use is such as Bramwell could not have imagined.

The first of these three lectures was in the nature of a general survey, outlining the development of the various types of engine as regards combustion, materials and manufacture. It is only in the last twenty years or thereabouts that the processes of combustion in petrol engines have been elucidated. Such well-recognized phenomena as 'pinking' and 'knocking' were known to be of importance in practice, but only the vaguest ideas were prevalent regarding the conditions which give rise to them. Although finality has by no means been reached, the systematic investigations of Ricardo and others have given the engine designer a sound basis on which to work.

In the compression-ignition type of engine, the development of 'airless' injection has been the most important improvement in combustion processes, as the resulting simplification of the engine has extended its field of application and given an impetus to its further improvement. Striking developments have also taken place in the materials used in their construction and in methods of manufacture, with great advantages in the reduction of weight relative to power.

The steadily increasing speeds at which internal combustion engines are now designed to operate has led to a virtual modification of the working cycle from the constant-pressure combustion proposed by Diesel to one approximating more closely to the constant-volume combustion of the petrol engine. In the petrol engine the direct injection of the fuel avoids the loss which otherwise occurs during the scavenging process in the two-stroke cycle and has opened up a wider field for this type. Prof. Davies expressed the view that the development of two-stroke petrol engines for aircraft appears to be within the range of practical possibility, and that, given success in this field, the extension of two-stroke working to all forms of petrol engines used in transport may be only a matter of time. Discussing the relative merits of carburation and fuel injection for aircraft engines, he gave it as his opinion that, if the two systems had started together forty years ago, fuel injection would have been in universal use to-day. The secret development work done by the Germans to make fuel injection satisfactory has enabled them to use it in all their fighter and bomber aircraft. Given a satisfactory arrangement of the controls, it offers the advantages of elimination of freezing, better distribution, low consumption at reduced brake mean pressures, lower hydraulic resistance in induction by the absence of choke and the possibility of two-stroke working.

An interesting comparison was made between the Rolls-Royce Merlin and a captured Daimler-Benz engine. Both develop practically the same power at take-off, but as the former is 27 litres against 33·9 of the German and their respective speeds are 3,000 and 2,400 r.p.m., the specific rating of the British engine is much higher. The Rolls-Royce has a two-

speed drive to its supercharger, while the Daimler-Benz has an infinitely variable hydraulic drive which permits of the speed and therefore the charge being suitably adjusted to altitude. Prof. Davies stressed the need for improved superchargers and scavenging pumps, as increased efficiency of these gives the advantages of reduced power required to drive them, lower cycle temperature with increase of charge density and of volumetric efficiency.

A type of engine of which little has been heard in Great Britain is the coal-dust engine, a point of some importance since British coals are more suitable for the purpose than those found in Germany, where development work has been done on this type. Diesel himself originally proposed such an engine but was unable to make it practicable. The Schichau Company of Elbing has carried out researches on a single-cylinder engine developing 160 h.p. at 200 r.p.m. Commercially, it has found the delivery of coal-dust ready for use direct from the mine in trucks to be most suitable, and the special removal of ash from the coal-dust to be uneconomical. Ignition temperatures vary from 300° C. for lignite to 600° C. for anthracite. The dust is used in the same fineness as for boilers, finer grinding being unnecessary as only 2 per cent in calorific value is lost to exhaust.

An auxiliary ante-chamber attached to the cylinder serves as a lock in free communication with the cylinder, and the fuel is admitted to the lock chamber by the fuel valve during the later part of the suction stroke, at the end of which the valve closes. During the instroke, compressed heated air is admitted and partial combustion occurs in the lock chamber as top dead-centre is reached. The resulting excess pressure in the chamber evacuates the contents into the cylinder during the expansion stroke. A continuous brake thermal efficiency of 25 per cent has been attained, but the main difficulties include wear of cylinder liner, wear, leakage and fracture of piston rings, pitting, erosion and sticking of the fuel-valve, and burning and erosion of the ante-chamber nozzles.

Concluding with some remarks on future developments, Prof. Davies pointed to the importance of research. For the last Schneider Trophy races the improvements in the aerodynamic properties of the aircraft and in the performance and reliability of the Rolls-Royce engine were obtained from comparatively modest outlays privately provided. Such an example shows the vast possibilities of well-directed research, and the reward of funds provided for the purpose.

FORTHCOMING EVENTS

Tuesday, April 22

INSTITUTION OF CIVIL ENGINEERS (Road Engineering Section) (at Great George Street, London, S.W.1), at 5 p.m.—Mr. Arthur John Hamblin Clayton: "Road Traffic Calculations".

Wednesday, April 23

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. T. Neville George: "The Development of the Towy and Upper Usk Drainage Pattern".

Friday, April 25

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, London, S.W.1), at 2 p.m.—Mr. G. E. Windeler: "Mechanical Mishaps".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6.45 p.m.—Prof. J. F. Baker, and Mr. J. W. Roderick: "Plastic Theory: its Application to Design".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE TEACHER QUALIFIED IN ELECTRICAL ENGINEERING in the Blackburn Municipal Technical College—The Director of Education, Education Offices, Library Street, Blackburn (April 23).

CHIEF EDUCATION OFFICER to the Darlington County Borough Education Committee—The Chief Education Officer, Education Office, Darlington (April 28).

WOMAN GRADUATE LECTURER IN EDUCATION at the Bingley Training College—The Education Officer, County Hall, Wakefield, Yorks. (May 2).

ASSISTANT TO THE DIRECTOR OF EDUCATION with special reference to ELEMENTARY AND SECONDARY EDUCATION—The Director of Education, Education Offices, Leopold Street, Sheffield 1 (May 3).

CIVIL ENGINEERING ASSISTANT TO THE TEES VALLEY WATER BOARD—The Engineer and Manager, Water Board Offices, Corporation Road, Middlesbrough (May 5).

RESEARCH OFFICER IN THE MENTAL DISEASE RESEARCH DEPARTMENT—The Secretary, The University, Edmund Street, Birmingham 3 (May 16).

READER IN PHARMACOLOGY—The Secretary, The University, Edmund Street, Birmingham 3 (June 1).

ASSISTANT ENGINEER FOR THE SUDAN GOVERNMENT RAILWAYS—The Controller, Sudan Government London Office, Oxford Hotel, 201 Clifton Drive South, Lytham St. Annes, Lancs. (quoting 'Assistant Engineer').

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 46, Section A, No. 9: Boolean Algebra and Probability Theory. By T. S. Broderick and E. Schrödinger. Pp. 103–112. 1*s*. Vol. 46, Section A, No. 10: Matrices of the Finite Period. By Olga Taussky and John Todd. Pp. 113–122. 1*s*. Vol. 46, Section A, No. 11: The Region of Bright Nebulosity in the Coal Sack. By E. M. Lindsay. Pp. 123–128+2 plates. 1*s*. Vol. 46, Section B, No. 6: Note of the Cytology of Human Uterine Glands in the Gravid Phase. By J. Brontë Gatenby and Olive E. Aykroyd. Pp. 97–100+plate 7. 1*s*. Vol. 46, Section B, No. 7: The Effects of Ultracentrifuging Human Oocytes. By Olive E. Aykroyd. Pp. 101–108+plates 8–10. 1*s*. Vol. 46, Section B, Nos. 8, 9: Description of Six New Species of Bassine Ichneumon-Flies, with Notes of some Others; A New Species of *Blacus* (Hymenoptera: Braconidæ), with some Notes of other Species of the Genus. By A. W. Stelfox. Pp. 109–124. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [113

Proceedings of the Royal Society of Edinburgh. Section B (Biology) Vol. 61, Part 1, No. 1: The Œsophagus of the Stenoglossan Prosobranchs. By Alastair Graham. Pp. 24. (Edinburgh and London: Oliver and Boyd.) 2*s*. [193

Other Countries

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1940. (Publication 3600.) Pp. ix+115. (Washington, D.C.: Government Printing Office.) 25 cents. [113

Fisheries Research Board of Canada. Bulletin No. 59: The Chemistry and Technology of Marine Animal Oils, with Particular Reference to those of Canada. Edited by H. N. Brocklesby. Pp. 442. (Toronto: Fisheries Research Board of Canada, Toronto University.) Paper, 2.95 dollars; cloth, 3.80 dollars. [113

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 34: Some Practical Results of Sugarcane Research in India. Pp. 41. (Delhi: Manager of Publications.) 1.8 rupees; 2*s*. 3*d*. [133

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 135: Investigations on the Storage of Jonathan Apples grown in Victoria. By Dr. S. A. Trout, G. B. Tindale and Dr. F. E. Huelin. Pp. 96+4 plates. (Melbourne: Government Printer.) [143

Annals of the Carnegie Museum. Vol. 28, Art. 11: An Archæological Collection from the Belcher Islands in Hudson Bay. By Diamond Jenness. Pp. 189–206+plates 14–22. (Pittsburgh, Pa.: Carnegie Museum.) [143

Field Museum of Natural History. Zoological Series, Vol. 24, No. 16. Reptiles and Amphibians from Central Arabia. By Karl P. Schmidt. Pp. 161–166. 10 cents. Zoological Series, Vol. 24, No. 17: Malacological Notes, 2: A New Marine Prosobranch Snail from the Yucatan Coast. By Fritz Haas. Pp. 167–174+1 plate. 30 cents. Zoological Series, Vol. 24, No. 18: New Termitophilous Diptera from the Neotropics. By Charles H. Seevers. Pp. 175–194. 15 cents. (Chicago: Field Museum of Natural History.) [193